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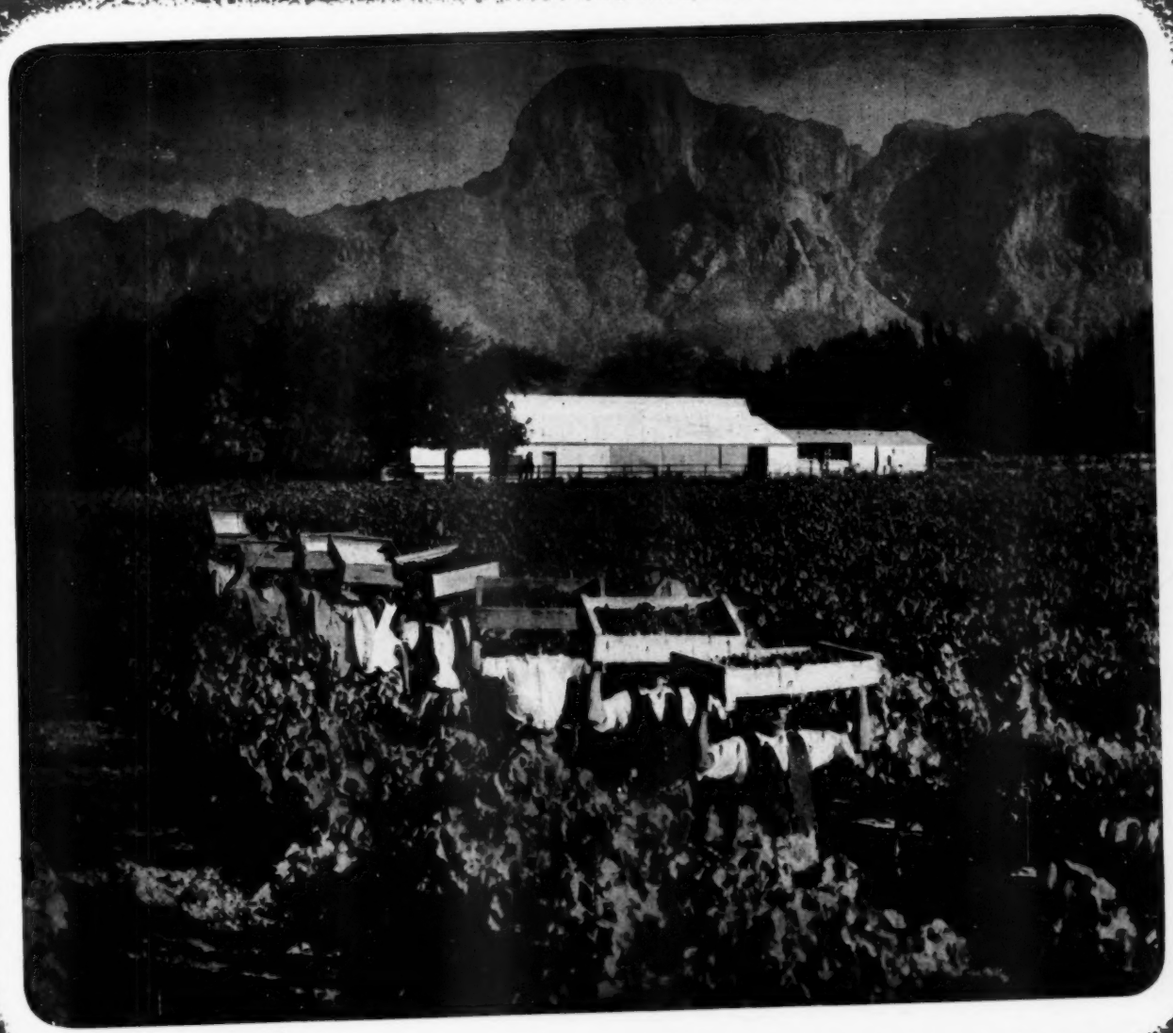

VOLUME 2, No. 11

NOVEMBER 1950

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THIS MONTH'S COVER

Gathering the grape harvest in the Paarl Valley, Cape Province. The town of Paarl, lying 36 miles east of Cape Town, is a busy agricultural and industrial centre, surrounded by gardens, orange groves and vineyards; the main agricultural products are fruit, tobacco, brandy and wine. Vineyards have been cultivated in this valley since the seventeenth century.

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Editorial Comment

Research vintage

JUNE, July, August and September may perhaps be termed the vintage months of scientific research, at any rate in the Northern Hemisphere, for it is then that the ever-increasing number of scientific conferences, national and international, usually take place and provide an opportunity for stock taking and assessment of the chief advances made during the preceding period.

The current year has been no exception, for apart from gatherings like the World Power Conference sponsored by UNESCO, which took place in July, we have had, to quote a few examples, the VIIth International Botanical Congress held in Stockholm, of which an account of the highlights appears on another page, and the IVth International Congress of Soil Science in Amsterdam, of which we hope to publish an account later, while the annual meeting of the British Association can always be relied on to provide some striking features.

Such conferences are obviously very valuable. It may perhaps be questioned whether the participants usually manage to assimilate anything but a fraction of the feast of information such gatherings provide—for example, we are told that at the Stockholm Botanical Congress over 600 papers were presented. Moreover, a not unusual accompaniment is numerous manifestations of public and private hospitality which, although enjoyable and welcome entail a certain amount of bivalent candle burning. Consequently their termination, especially in the case of the more elderly participants, is not infrequently accompanied by what, in medical parlance, is termed, symptoms of lassitude. But after all, junketings and entertainments are traditional concomitants of harvests, and why should it be otherwise in relation to research, provided the harvest is a good one ?

This year the harvest is fully up to the average and though no outstanding and epoch-making discoveries have come to light there have been many points of interest in the agricultural field and there have also been one or two notable pronouncements.

Energy and agriculture

SIR HAROLD HARTLEY'S presidential address to the British Association was, in a sense, a complement and a pendent to that of his predecessor in the presidential chair last year—Sir John Russell—for while the latter considered the question of the future of the world's food supplies and the ability of the earth's surface to produce the increasing amounts of food and raw materials necessary for the continued existence of the rapidly expanding populations, Sir Harold dealt with the corresponding demand for energy, which is increasing at an even more startling rate. As he himself put it ' there is a limit to the capacity of the human stomach for food but none to man's appetite for energy.'

Probably in no sphere is the demand for energy increasing more rapidly than in that of agriculture; we take pride, and justly, in our increasing ability to supply the place of human and animal energy in agricultural production by the use of mechanical power, thereby enabling output per human being employed to be enormously stepped up; but the fact remains that, notwithstanding this, the consumption of energy per unit produced, irrespective of its origin, shows no signs of diminishing; on the contrary it is increasing. Moreover, as Sir Harold by implication reminds us, the increasing needs for energy arise not only in connection with the preparation of land and growing, harvesting and processing of the crop, but also for the extraction and manufacture of a whole host of products such as fertilisers, insecticides and raw materials, for manufacturing the ever-increasing range of farm implements, irrigation equipment and other machinery necessitated by increasing crop production.

Indeed, it may well be that in the foreseeable future agriculture may become one of the greatest consumers of mechanical energy.

Electrified farming

IN discussing world resources of energy Sir Harold pointed out that if all the world's reserves of water power were developed their output would equal the total inanimate energy man is using today. In many parts of the world steps are being taken to develop these resources and with the development of numerous hydro-electric schemes in project or in operation all over the world, farmers are turning their attention increasingly to electricity as a source of power in farming operations. The question is largely bound up with the price per unit at which electric energy can be delivered, and where water power is abundant this can usually be kept well down, notwithstanding that the initial expenditure for the installation of generating plants and power transmission lines is a heavy item. In countries where water power is abundant, e.g. Sweden, Switzerland and parts of Italy, its use is already widespread, and it is often a matter of surprise to visitors to remark the extent to which electric power is available on remote and apparently inaccessible farmsteads.

Once power is available the advantages which the electric motor offers over the internal combustion engine for driving, at any rate, stationary machinery are obvious: the difficulty of fuel supply is eliminated, it starts with 'the flick of a switch,' facilitates cleanliness, needs little maintenance, while depreciation is minimal.

Apart from the ordinary uses for lighting and the driving of light machinery, such as chaff cutters, saw benches and the like, or for operation of milking machines, dairy appliances and so forth, new developments are constantly appearing. Thus in horticulture heating of glasshouses by electricity and the use of electric refrigeration for fruit storage are developing. Another new development is electric heating for grain and grass dryers, of which a number have been installed in various parts of the world. Apart from the high initial cost, they have met with a fair amount of acceptance. In the United States—the land of new ideas—it is reported that electric insect traps have shown promising results. Electric fencing seems another possibility, for, although these are at present mainly operated by batteries, it is but a step to couple up the fence to the power supply, once it is available, using appropriate devices to reduce the voltage to the point desired.

The possibility of using electricity for moving machinery in the field from power offtakes is, perhaps, not quite so remote as might at first sight be supposed; already we have electric hedge trimmers and similar devices and new developments seem highly probable.

Indeed, although the era of push-button farming has not yet fully dawned, its advent in the foreseeable future seems almost certainly assured.

Quality in agriculture

'QUALITY in Agriculture' was the title and the basic theme of Prof. H. D. Kay's address to Section M of the British Association this year. As was to be expected the main examples which he selected to illustrate his arguments were drawn from the dairy industry, but much of what he had to say had an application to all aspects of agricultural industry.

Quality is in fact one of the most important as well as one of the most elusive factors. Its definition and valuation often depend on the assessment of properties which at present do not permit of exact measurement; particularly does this apply in regard to such things as taste and flavour, so important in the case of many products used as food; tea, coffee and cocoa immediately come to mind in this connection. In the case of raw materials for industry quality depends on meeting the requirements of manufacturers in respect of properties which, although the manufacturer knows what he wants, are often hard for the primary producer to assess accurately for himself.

Moreover, the situation has often been complicated by the fact that for some groups of produce sales have been made through the agency of brokers or intermediaries who are credited with highly expert knowledge of manufacturers' needs, and although undoubtedly this exists it is usually based on rule of thumb methods. It would almost seem that on occasion these may have been dictated not so much by what the manufacturer wants as by what the broker thinks he ought to want or by some characteristic in packing or preparation which the broker finds assists him in the taking of samples or in making his assessment.

In some directions there are indications of advances. Thus in the cotton industry the Shirley Institute affords invaluable assistance in helping to assess the value of new strains of cotton evolved by experimental workers, besides performing its main function of assisting manufacturers to solve their numerous problems. An even more significant step is the establishment in Cairo of a cotton testing station at which the spinning qualities of Egyptian cottons can be accurately assessed. In the rubber industry similar developments are in progress, notably at the Rubber Research Institute of Malaya; the polarimetric assay of raw sugars has long been standard practice in the sugar industry, and constitutes an outstanding example of a case where the scientific assessment of quality has become the dominating factor and has completely replaced rule of thumb methods. What is needed is similar development in many other industries, and it is not always an easy matter to devise such methods. In the field of flavour, taste and smell we still remain dependent and must, it seems, continue to remain dependent on human judgment with the liability to error which human frailities are unfortunately so prone. Nevertheless, the triumphs of science in other and even more intricate fields inspire the hope that some day perhaps the means may be achieved of recording and measuring accurately and reliably these highly important but elusive properties.

Biological races of insects

IN addressing the zoological section of the British Association, Dr. V. B. Wigglesworth chose the somewhat austere title of 'The Science and Practice of Entomology.' Actually much of the material in it should, as the saying goes, give cause not only to those concerned with the particular science in question, but also with the practical every day business of farming 'furiously to think.'

Today insects have, as Dr. Wigglesworth put it, 'come into their own'; not perhaps a consummation devoutly to be wished from the insects' point of view if, indeed, they can be said to have one, but

certainly essential if the well being, health and even continued existence of the increasing world populations are to be assured. For although some insects are beneficial a vast number are very much the reverse, and indeed it is no exaggeration to say that of the many dangers, hazards and losses which daily confront the human race those attributable to the ravages, depredations and attacks of insects and the maladies they carry with them take a very high priority in importance.

Dr. Wigglesworth asks whether, in view of the enormous range of newer insecticides which have come to the fore in recent years, the entomologist may not be in danger of being outmoded by the organic chemist; to this query he returns an emphatic negative pointing out that the use of more and more insecticides creates new problems as fast as it solves the old ones.

The reason for this is that the world of insects is in a state of flux, thereby in effect parallelling the position in the larger world of human affairs. Insects possess extraordinary powers of adaptability *vis-à-vis* changing conditions. Insects are constantly changing in abundance, in habits, and in the amount of damage to human interests they bring about. Within species biological races of insects are produced with varying tastes and powers of resistance. The advent of new methods of combating their depredations is often followed by new biological races capable of resisting them. It is, in fact, an unending struggle which calls for increasing vigilance and ingenuity. It has been stated that the secret of successful generalship consists in knowing your enemy and being one jump ahead of him, and this applies no less to the war against insects as in the field of human hostilities.

To pursue the analogy a little further, the entomologist combines the role of an intelligence officer and a co-ordinator at supreme military headquarters. It is he who helps to bring news of changes in the dispositions of the enemy and of new powers of resistance or attack of which they may have become possessed. It is he who can point out weak spots in his defences and suggest ways of getting round them, and on him the organic chemist must rely on checking the efficacy of the materials he produces. Moreover his aid is invaluable at times in restraining the activities of the organic chemist whose products sometimes threaten the existence of friends and foes alike.

We can therefore agree fully with Dr. Wigglesworth that the need for entomologists and for entomological research is increased and not diminished as the result of recent discoveries. More entomologists are needed, and particularly entomologists 'who know the world of insects in the round' and who can 'guide intelligently, supplement and sometimes even supplant chemical methods of control by the more subtle methods of biology.'

Resistant crop varieties

THE considerations in the preceding paragraphs naturally lead to reflections on the related matter of pest and disease control by the evolution of inherently resistant varieties of plants. This is in fact the third great method of disease control, since the production of varieties which are immune or resistant eliminates the necessity for expenditure on control measures and may in many cases be the only available means of combating disease. Many examples leap to mind of industries which have been saved from extinction by the introduction of varieties resistant to particular maladies. A classic case is the sugar cane industry in the West Indies which, many years ago, was rescued from the ruin which threatened it when the Bourbon cane, formerly almost exclusively cultivated, broke down with stem disease and was replaced by other varieties capable of resisting it. Another example is the success which has attended the breeding of rust-resistant wheats. The plant breeder is indeed the third great ally upon whom the farmer has to rely in his struggle against nature, and consequently the query 'what constitutes disease resistance?' is a very natural one.

The answer seems to be that there is no single operative factor; it may be that disease resistance is due to developing some physical character which renders the enemy fungus or insect less able to penetrate the plant tissues, *e.g.* hairiness, which is being utilised in the Sudan in attempts to breed varieties of Egyptian cotton resistant to jassids. On the other hand resistance may be due to more elaborate and intricate factors, some of which are still but little appreciated.

The question came in for a good deal of discussion at the VIIth International Botanical Congress recently held in Sweden, where 'hypersensitivity' as a factor in disease resistance was debated. The essential feature of this intriguing phenomenon is that hypersensitive plants are actually very susceptible to attack by specific fungoid maladies. When they are attacked at any point the infected cells rapidly die and the infected point becomes surrounded by a zone of dead tissue through which it cannot penetrate further. Moreover the dying cells may produce a toxin which accelerates the death of the fungus. As a result the paradoxical position may arise that a plant which is naturally very susceptible to attack is also resistant to the disease by reason of its very susceptibility. It is true that the phenomenon is, so far as is known, not a general one and its validity and the possibility of application in practice must remain for the future to show; nevertheless, we are told that varieties of plants exhibiting this character have been grown and, as we have said, the possibilities are certainly intriguing.

Toxic chemicals in tropical climates

IN an article on another page Dr. W. E. Ripper deals with precautions required in handling toxic chemicals used in crop protection. The subject has attracted much attention recently in Great Britain, particularly in view of casualties which have occurred in this connection, and recently the Ministry of Agriculture appointed a working party with the terms of reference ' to make recommendations for the promotion of safety of workers in the agricultural use of substances toxic or harmful to human beings.'

It has been found time and again that the use of some of the newer insecticides, notably DNOC, is particularly dangerous during hot weather and it is then imperative that workers should wear protective clothing and take particular care to avoid risk of poisoning. Accidents are invariably due to neglect of some necessary precautions, and one source of weakness is that the wearing of protective clothing during very hot weather can be very trying; in these conditions the temptation to workers to discard heavy protective clothing and to accept what they may regard as only a slight risk may be very strong unless the dangers are very completely understood.

But if protective clothing is necessary in Europe it is, *a fortiori*, presumably even more so in the tropics, where every day is warm and dangerous and workers are usually semi-naked rather than fully clothed. The use of the newer insecticides under tropical conditions is extending fairly rapidly in some regions, and to us it seems obvious that precautions against toxic hazards under tropical conditions require very special consideration. It is accordingly to be hoped that the working party may find itself in a position to take into account this aspect of the question, notwithstanding that primarily it is concerned with conditions in Great Britain.

Monoculture and self sufficiency

A CHARGE which is frequently levelled against plantation agriculture is that its tendency to concentrate on a single product is a source of weakness, and that it would enhance stability if plantations conjoined with the production of their principal staple, the cultivation of suitable food crops combined with animal husbandry.

Numerous discussions of this question have taken place in regard to a number of industries, notably sugar in the West Indies, coffee in East Africa, rubber in Malaya, and cocoa in West Africa and the West Indies. Some experiments have been undertaken in various places to explore the possibilities.

At a conference held at Tocklai at the end of last year the same question was discussed in its relation to the Indian Tea Industry, when it was urged that the extension of food cultivation should be put in hand at once, even if only on a small scale to commence with. It was also pointed out that if mechanical plucking and pruning became generalised much more labour would become available for food production.

Some plantation crops, notably cocoa and to a less extent tea and oil palms, are highly selective in their soil and climatic requirements. It follows that where ever conditions are particularly favourable to the growth of a special crop it may be wiser to reserve such lands for it rather than to attempt on them other forms of agriculture for which they are less well adapted.

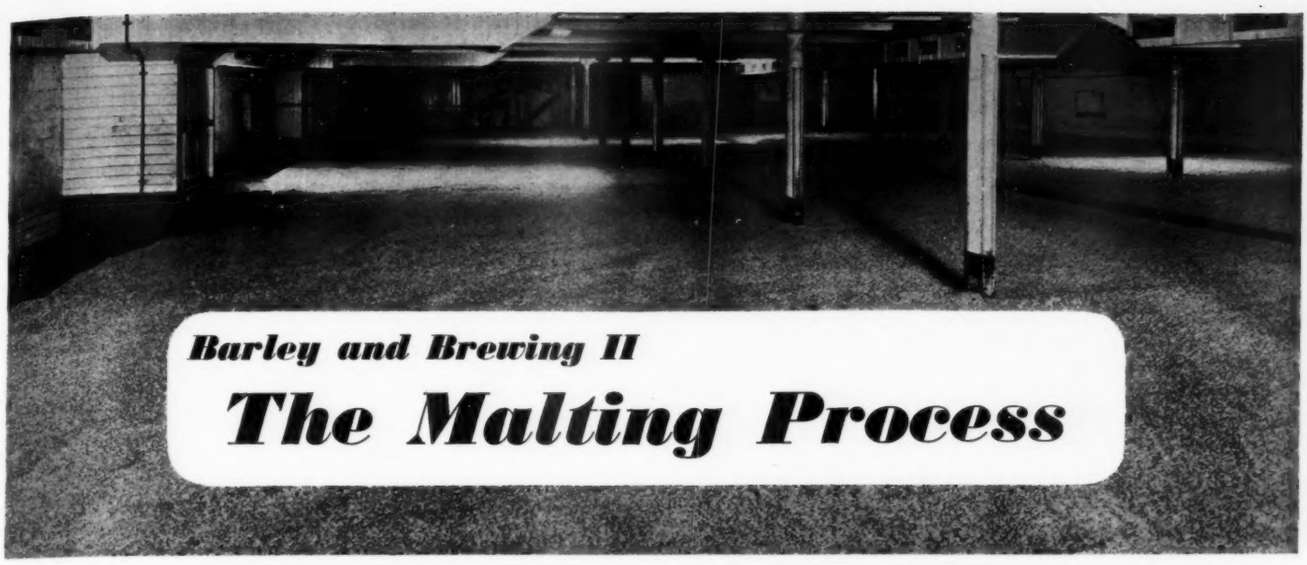
For example, in the Gold Coast, areas which comprise some of the best cocoa lands in the world have gone out of cocoa cultivation by reason of swollen shoot disease and are now being cultivated in food crops. Such a state of affairs is obviously undesirable and the aim should rather be their ultimate rehabilitation in cocoa. This, of course, applies in particular cases and does not invalidate the general argument. It does, however, underline the need for controlled land use and for ensuring that in all areas the cropping system should be adapted to the natural conditions as closely as possible.

The Desert Locust

IN October we had occasion to comment in these columns on the new threat from the Desert Locust which has developed in the Middle East. In this connection we have received from Dr. B. P. Uvarov, Director of the Anti-Locust Research Centre, a letter which we reproduce on another page, in which he discusses and describes the present position and puts into full and correct perspective some of the points raised in the paragraph in question.

Coming from such an authoritative source this statement is specially welcome and it will be read, we feel assured, with attention. The advances in our knowledge of this age-old enemy of mankind which have been achieved in recent years are indeed remarkable and with them the name of Dr. Uvarov will always be associated.

There seems to be reason to hope that, given the necessary personnel and resources combined with the collaboration of the authorities of the territories concerned, many of which are difficult of access, little known and almost completely undeveloped, the degree of control which has already been achieved over the red locust and the migratory locust in other parts of Africa should ultimately be capable of attainment in the case of the desert locust.



Barley and Brewing II

The Malting Process

'From the steep the saturated barley is taken to the floors and spread out'

A. CORY WRIGHT

Last month we published an article by Dr. Hunter discussing the characteristics of malting barley. Here, the malting process and the manner in which different types of barley are required for the production of malt for different purposes are described and discussed.

ACCORDING to the Dictionary malt is 'barley or other grain steeped in water and allowed to sprout.' To most people, however, the word is connected mentally with only one cereal, namely barley, and actually very much more barley than any other cereal is malted. It is therefore, not proposed to elaborate the process of malting cereals other than barley in this article. The word malt is also connected in the minds of most people with beer, and to a lesser extent with malt extract and malted milk. There are, however, a number of uses, other than brewing, to which malt in some form or another is put, including distilling of spirits, the brewing of vinegar, and the production of yeast. In the form of extract as a syrup or a powder or flour, malt has many more uses ; in the baking industry for example, for improving the bloom and volume of the loaf and as a yeast food, in textile factories and laundries for de-starching, in the confectionery trade for flavouring and to some extent in the preparation of gum.

But malt of the same character is not suitable for all these purposes ; indeed one grade of malt is not suitable for all types of beer. The same malt is not suitable for pale ale, mild ale and stout, or for bottom fermentation beers such as Pilsner and Munich. In addition there are roasted malts used for flavouring and colouring, and the preferences exercised by individual brewers for slight variations, both physical and analytical, must not be overlooked. It may, however, be said that any barley which will germinate freely can be made into malt suitable for one or other of these purposes ; in other words, all barley which will grow readily is maltable. Growers of barley must not take this to mean that all barley will receive the same price. In the long run this, as in all other commodities, is controlled by the law of supply and demand, and in some grades of barley the supply far exceeds the demand.

The malting process

Before going into these refinements it is as well to give an outline of how malt is made in an ordinary floor malting. This process has gone on for thousands of years, often in quite small maltings which can be worked by one man. After the selection of suitable barley the grain is screened to remove all foreign matter, such as weed seeds, half-corns, and immature kernels. If necessary the barley is sweated, that is, dried at a moderately low temperature, with the object of levelling the moisture content throughout the bulk, and to make it possible to store the grain in large quantities. Whether the barley is sweated or not it is advisable to carry out germination tests to ascertain that the barley is not dormant, and that it is not prevented from growing for any other reason.

Assuming the barley has reached its full germinative energy it is steeped, that is, submerged in water for a period. The time taken to steep depends on the temperature of the water and to a lesser extent its hardness, also on the variety, size and degree of ripeness, and on the purpose for which the malt will be used. From the steep the saturated barley is taken to the floors and spread out. In olden times when tax was on malt and not on beer as it is today the malt was not spread but put in a 'couch' for the excise man to measure. At one time it was considered advisable to leave the malt couched, that is, in a deep heap, to stimulate sufficient heat to start germination. But today many maltsters think that except when the weather is very cold it is better to spread the barley less thickly on the malt floor so as to allow free percolation of air and hence oxygen without which barley cannot germinate.

After a short time the barley starts to 'chit' and little white buds which ultimately develop into roots appear at the end of the corns. The rate of germination is controlled by turning either with a fork or a shovel, or by raking, and under certain conditions it is stimulated by sprinkling with water. When the roots and acrospire or shoots of the grain are considered sufficiently advanced, the green malt, as it is then called, is loaded onto a kiln, dried and, for some purposes, cured, except when the malt is required for a few processes in which it can be used in its green state.

Losses during malting

This may sound very simple, but it must be remembered that barley grain is a living thing, and its behaviour is easily influenced, and that during the process

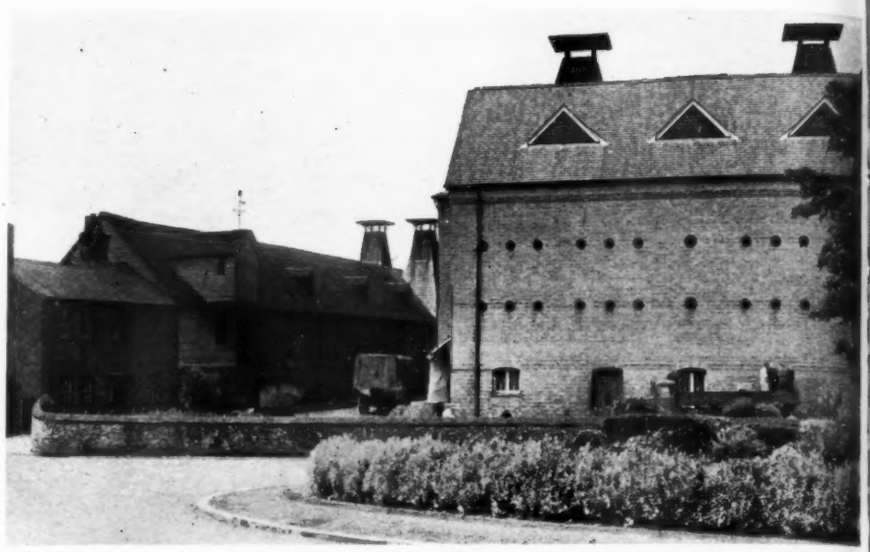
both physical and analytical changes are going on, which entail losses in weight. These losses, which amount to about 25% of the weight of the barley, are made up by the moisture ; barley naturally may have anything from about 12% to about 25% of moisture in a wet country, and some types of malt should come off the kiln with as little as 1 to 1½% of moisture ; the rootlets, called culms or chives, and respiration account for the remainder of the loss. Obviously it is in the interests of the maltsters to keep these losses as low as possible, provided that the quality of the malt is not affected thereby.

Chemical changes during malting

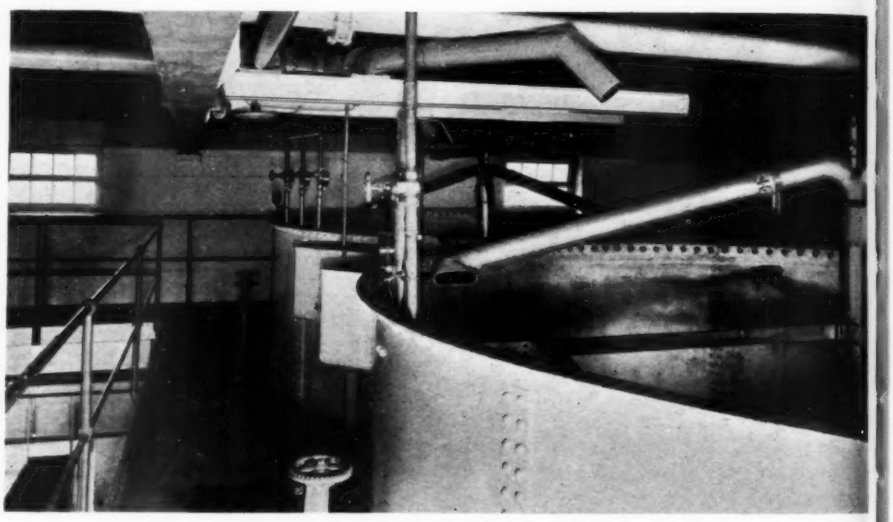
The chemical changes brought about in the grain during malting are caused by enzymes, the most important of which are those which convert starch into sugar, called diastase, and that which solubilises the protein, and it is the quantity and percentage of starch and protein in the barley and the extent to which they undergo conversion that determines the suitability of the malt for any given purpose. It is obvious that unless suitable barley is selected it is impossible for the maltster to make it into malt for the purpose intended. Economic factors naturally have to be considered ; the buyer wants the malt he buys to yield him as much beer, whisky, vinegar or malt extract as is possible, consistent with the sugars being in the right proportion, the proper percentage of nitrogen being soluble, and the diastase being the desired figures, usually expressed in degrees Lintner.

Malts for pale ale production

In the British Isles and in countries where pale ale is brewed, the most difficult barley to grow or purchase is that suitable for this purpose, and therefore commands the highest price. Suitable barley for this class of beer should be fully ripe, thin-skinned, bright, and of course, in good condition, and on this account is said to have quality. Unfortunately there is no exact measure of quality, but there is a guide, everything else being equal. The lower the percentage of nitrogen in a variety the better the quality, provided the barley is bright. It is indeed possible to forecast the extract in the malt from analysis of the barley. Extract is the percentage of sugars which can be extracted from the malt, usually expressed in brewer's pounds. This extract, assuming the malt to be correctly made, depends on the variety of the barley, the size of the grain, expressed in the weight of a thousand corns, and the total nitrogen. The larger the barley kernel and the lower the nitrogen, the higher the extract. The extract is what the brewer wants, as this is what he converts into beer, and for his pale ales, which are comparatively strong, he looks for a high extract. Nitrogen, however, indicates the presence of protein which, when soluble, furnishes food for the yeast used in fermenting the extracted liquor or wort, and for weaker beers the brewer wants a barley of a rather higher nitrogen content. This percentage of nitrogen in barley is to a certain extent a relative matter ; under certain climatic conditions 1.6 or 1.7% is considered low, whereas in England championship barley is usually about 1.2%.



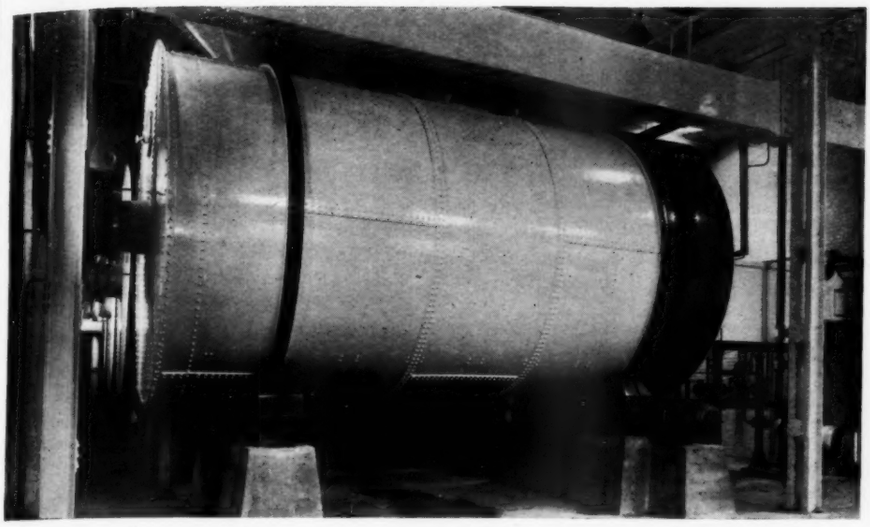
Maltings, ancient and modern, the main difference being capacity



Steep tank with aeration and re-circulating equipment

Varieties suitable for pale ale

With regard to varieties suitable for pale ale, Spratt-Archer and Plumage-Archer have stood the test of time, and no doubt the recent selection, Earl, will prove to be equally good from the brewers' point of view. Another recent addition to apparently ' quality ' barleys, Pioneer, has not as yet received the unqualified approval of brewers. Grown under certain conditions it can be a very handsome barley, under other conditions it can be very poor material indeed. These extremes may be caused by lack of potash or by sowing too early or too late. Varieties usually grown on the Continent, such as Kenia, Maja, Freja and Ymer, are not popular with brewers of pale ale. This is unfortunate as agriculturally these varieties exhibit outstanding merit. It is difficult to say exactly why they are unsuitable except that there is some evidence that although they yield their full predicted extract, their protein will not modify easily. It is too early as yet to say whether the crosses of such



View of a Box drum, one of the methods used for moving the malt

Oil firing equipment for a kiln

varieties with barleys of known merit will combine the shortness of straw, the early ripening of the continental type and the brewing quality from a pale ale point of view of Spratt-Archer and Plumage-Archer.

Malts for lager beer

The problems confronting the maker of malt suitable for the Pilsener and Munich types of lager beer are quite different. Speaking generally, barley of a higher nitrogen content is selected and the conversion on the malt floor is not allowed to proceed anything like so far—the germination period is about half and the kilning is also quicker. It is impossible to say exactly how far the modification should be allowed to proceed, as this depends so much on the particular requirements of individual brewers. As a general rule, the maltster has some difficulty in persuading a sufficient percentage of the protein to modify for pale ale malt, and almost as much trouble to prevent his malt from over-modifying for lager. It is difficult to say exactly what makes an ideal barley for lager-type malts. It may be climatic, cultural or varietal differences, or a combination of all three that matter. Lager malt is exported from Great Britain, where Spratt-Archer predominates, and from Scandinavia where Kenia, Maja and similar barleys are better known ; so it may be that, providing the protein content and the treatment during malting are suitable, the variety of barley is not important.

Malts for malt extracts

The requirements of a malt extract manufacturer are somewhat varied. It can be said that for many of his extracts he wants as much diastase as is possible, and barleys most suitable for this purpose are those grown in areas with a short growing season, such as parts of Canada. The most suitable barley grown there is usually of the 6-rowed type and has a nitrogen content of at least 2%. Barleys with this nitrogen content are sometimes grown in other parts of the world, but seldom yield the diastase of the Canada barleys, and it is thus probable that it is the climate rather than the variety that matters. To obtain the maximum diastase a comparatively long period on the malt floor and a low kilning temperature are required.

Malting and weather

In the kind of malting previously described the quality of the malt is to a certain extent dependent on the weather, and it is impossible to make good malt in hot weather as the growth of the grain is then too vigorous and the formation of mould is encouraged. Too cold weather on the other hand retards growth on the malt floor and therefore disorganises the work in the malting. This disadvantage was realised at least as long ago as 1842 when patents were taken out for a pneumatic system of malting.

Pneumatic malting

In this system of malting the barley is kept in a container in which the temperature, humidity and supply of oxygen are controlled by pumping or drawing through conditioned air. In the earlier stages of pneumatic malting it was thought that if the correct amount of air in the right conditions was applied, turning could be dispensed with. It was soon realised that this was wishful thinking, and means of moving the malt were devised.

From these ideas three systems of pneumatic malting evolved and are in use today. For two of the systems the barley is placed in drums and the third in cases, called respectively the Galland Drum, the Box Drum and the Saladin Box In all systems the incoming air has to be in the same condition, that is, fully saturated and at a temperature slightly below that at which it is desired to keep the malt. If the incoming air is not saturated when exchanging its heat with the malt, the barley becomes dry and eventually loses its vigour. The air is usually conditioned by sprays of water, using the loss in temperature by evaporation as well as direct exchange of heat. In very cold weather the water may be warmed, and in hot climates a refrigerator can be introduced into the system. For economic reasons it is possible to recirculate the air, relying on the sprays of

water to extract the carbon-dioxide given off by the malt. Towards the end of the growing period, for certain types of malt, it is beneficial to allow a concentration of carbon-dioxide to build up, thus preventing further growth without affecting the modification, as after a certain stage the modification continues after the growth is retarded, thereby lessening the malting loss.

The Saladin box

The method of moving the malt is different in all three systems, all of which have their advantages and disadvantages. The Saladin box is a narrow, rectangular case usually open at the top and constructed of any smooth material. It has a false perforated floor through which the conditioned air is passed. The turning is effected by driving a series of rotating spiral blades which lift lower layers of the grain to the top. These spirals are mounted on a carriage, the width of the box, and rotate in opposite directions. The disadvantage of this arrangement is that the last malt to be moved by one turn is the first to be moved by the next, and in a very long case this will lead to unevenness of growth.

The Galland drum

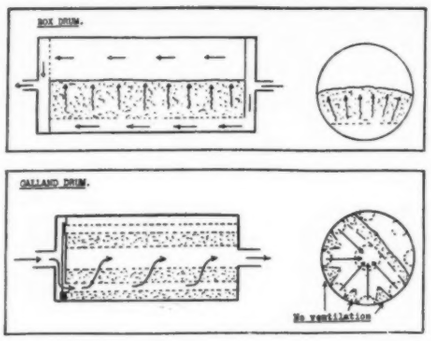
The Galland drum is a metal cylinder. The aeration is carried out through a large perforated tube at the axis and a number of lesser tubes round the periphery. In larger drums there are intermediate tubes. The drum is filled about three-quarters full so that one revolution effects a movement of every corn in the drum. As the outer tubes emerge from the malt a valve operated by a pendulum cuts off the air, thus preventing the air taking the line of least resistance and passing over the malt. The disadvantage is that there may be a number of areas through which the air does not pass.

The Box drum

The Box drum, like the Galland, is a metal cylinder, but its method of operation is really a combination of the Galland and the Saladin. Instead of perforated tubes, as in the Galland, it has a perforated floor similar to the Saladin. One revolution effects a complete turn of the malt. The disadvantage is that aeration cannot take place during the turn.

Air-conditioned floor maltings

In addition to the advantages of perfect control, all three systems effect a considerable saving in labour. Many brewers, however, consider that malt made by any pneumatic system has the disadvantage of a massed-produced article compared with the hand-made malt in a good floor malting, and comparatively recently many floor maltings have been air-conditioned. This is done by passing filtered cool air over the floors, thus keeping the atmosphere in which the malt grows at a constant temperature, but not allowing a cool current to impinge on the growing piece. This has many advantages over any pneumatic system except that of labour-saving.



Diagrams of the Box and Galland drums, showing air flows

Malt kilns

From the floors, boxes and drums, the malt is loaded on to a kiln. There are three methods of applying heat, namely, direct firing by anthracite coal, direct firing by oil fuel and indirect firing. In the production of malt suitable for top fermentation beers, anthracite has been used for many years. It is not possible to have such perfect thermostatic control as is the case with oil, and unless great care is used in the selection of the coal there is a possibility of the malt becoming contaminated by arsenic. In countries where it is difficult to obtain satisfactory anthracite it is common practice to use indirect firing. In this method as the products of combustion do not come into contact with the malt, any form of fuel can be used, and economic factors are all that need be considered.

Kiln construction

A kiln consisting of a single floor, constructed of wire or perforated terra cotta tiles over a disperser plate, is all that is needed for kilning malt when loaded comparatively thinly. Fans are often fitted in malt floors to improve the draught and speed up the process. There are various methods of economising in malt drying ; first, some kilns have two or more floors above each other. The green malt is loaded on to the top floor, which is the coolest, and dropped down to a lower floor to be finished off. The disadvantage is that for certain types of malt more draught is needed for the green piece than for the finishing piece, and it is difficult to adjust this to a nicety. Another method of economising is adopted in the Winckler kiln. On this the malt is loaded about four times as thickly as on a normal kiln. A very rapid current of air is then passed through the mass and when the malt is nearly dry the air is re-circulated instead of being exhausted through the top of the kiln. This type of kiln has another advantage in that it takes up only one-quarter of the room of a normal single floor kiln. The disadvantage is that there is a considerable lag between the top and bottom of the piece in reaching the desired temperatures. Finally, there is the thermotank system, consisting of a fan and trunking which enables the hot air to be recirculated when its humidity is sufficiently low.

Conclusions

The foregoing is a general outline of malt manufacture. Probably all maltsters adopt slightly different methods to arrive at the same end, but in practice the most important condition is to treat each bulk of grain on its merits rather than work by rule of thumb.

(Photos: p. 452 (bottom), p. 453, Messrs Robert Boby Ltd.)

Wheat Price: Uncertainty in France

French wheat producers are seriously worried about sales. At the annual congress of the Wheat Producers' Association, the president, Monsieur Deleau, said that the days of scarcity were a long way behind, and that today wheat producers had to look for foreign markets.

He stressed the necessity of a fair price and said that unless the Government assured such a price not only would the producer suffer but also the whole economic structure of France. The producers have agreed to carry the cost of organising exports at world prices, but only on condition that a fair price is paid for home-consumed wheat and that the Government is able to find the necessary foreign markets. Finally, the producers wish to ensure that a strict minimum amount of money will be used to aid wheat exports, and suggested between two and and a half and three million francs as a suitable sum; the producers further suggested that they should have control of the use of the funds. Under a new law not yet passed by parliament, the export tax will be deducted from the fixed price the producer receives.

Foliar Diagnosis and Plant Nutrient Requirements

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A good deal of interest has been aroused recently in a method of determining analytically the manurial requirements of crops from the amounts of nutrients contained in their leaves. This has been termed foliar diagnosis, and in the following article Dr. E. J. Hewitt, an authority on the subject, discusses the method and indicates its possibilities and limitations.

BEFORE proceeding to details it will be convenient first to survey briefly the development of the subject of plant analysis.

It was early assumed by Liebig (1840) that the supplies of nutrients in the soil were not inexhaustible; what was removed had ultimately to be restored in order to prevent decline of yields; the requisite amounts could be ascertained by analysis of the crop. Later (1863) he formulated the classical 'law of the minimum' wherein it was assumed that yields were limited by the nutrient present in minimum amount. Mitscherlich (1909) introduced the idea that the relative response to a fertiliser decreases with increasing amounts, and this was termed the 'law of diminishing returns.' Goodall and Gregory (1947) have drawn attention to two other 'laws' of interest in considering the relationship of yield to fertiliser supply. These are the 'product law' of Baule which attempts to account for the simultaneous increase of two nutrients in limiting supply and the 'reciprocal law' attributed to Balmukand in which the reciprocal of the yield is related to the sum of the reciprocals of several added nutrients.

Obviously the practical application of such laws, even (as is doubtful) if they are generally valid, will require extensive manurial experiments to determine for each site the level of manuring at which the increased returns will no longer be economic. Accordingly the possibility of correlating the chemical composition of the plant and its yield at the time of analysis with the fertiliser needed to obtain maximal economic yields is an alternative that has received extensive attention. The earliest attempts to do this date back to the time of Weinhold (1862) and Hellriegel (1867) who are credited by Goodall and Gregory with being the first to test the relation of plant composition to yield and nutrient availability.

Long Ashton field outfit for plant tissue tests

In the early analyses, whole plants, their roots, mature grain or straw (in cereals) and the whole of their aerial parts, preceded the choice of the leaf as the material for analysis.

A suggestion to use weeds as the index (preferably a specific weed) was made by Sir A. D. Hall of Rothamsted, who considered that a particular plant might be of general occurrence and could be sampled from manured and headland areas.

The foliar diagnosis method

The use of closely specified leaf sampling was introduced by Lagatu and Maume of Montpelier, who originated the term 'Diagnostique Foliare' in a series of papers published from 1924 onwards and relating mainly to the grape vine. The method was adopted shortly afterwards (1929 onwards) by Thomas and his associates in Pennsylvania and later, in modified form, by Halais and Craig in relation to sugar cane in Mauritius.

The original method of Lagatu and Maume involved the following procedure. The plant was sampled by selecting leaves at a specified point at intervals during the season. The three major nutrient elements, nitrogen, phosphorous and potash were determined and the results expressed as a percentage of the dry materials. These gave the absolute or total levels present. The relative proportions of each of these elements were then expressed as percentages of the total level and were held to reflect the trend or quality of the nutrition. The relative percentage values for each sampling were represented on triangular co-ordinates and their trend followed throughout the season.

The procedure of Thomas* and the Pennsylvania school is similar, but in this case whereas the 'quantity' or intensity of nutrition is still expressed by the sum of the total values in percentage terms the 'quality' of nutrition is defined in terms of what has been called the 'NPK unit.' This is obtained by converting the percentage values referred to above into milligram equivalents per 100 gm. and expressing each as a percentage of the total

*Thomas retains the use of N. P_2O_5 and K_2O for the quantity factors owing to the 'international character' of this terminology in agriculture.

Quantity therefore = %N plus $\%P_2O_5$ plus K_2O = S

$$\text{Quality (NPK Unit)} = \frac{\%\text{m.eq.N}}{\text{m.eq.N+P+K}} \text{ plus } \frac{\%\text{m.eq.P}}{\text{m.eq.N+P+K}} \text{ plus } \frac{\%\text{m.eq.K}}{\text{m.eq.N+P+K}} = 100 = \text{NPK Unit.}$$

NPK present also in milligram equivalents. The position of the NPK unit is then plotted on equilateral triangular co-ordinates.

The triangular method can also be used to show the seasonal changes in location of the mean value of the NPK unit in relation to varying fertiliser treatments which give high and low yields. In addition it is possible to derive a similar unit for K, Ca, and Mg.

The sampling procedure, although based on the use of specified morphological leaf positions, is selective and not random; it eliminates abnormal or sub-standard plants from the sample. No statistical treatment is included; in fact, statistical methods are criticised on the grounds of their being ' opposed to the whole spirit of biology ' (Thomas and Mack, 1944)—an attitude somewhat unfamiliar to present-day biology and, in so far as it concerns field trials and yields, it is surely inadmissible.

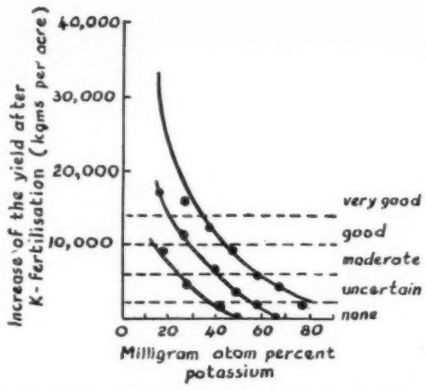
Halais and Craig working on sugar cane in Mauritius have dispensed with the use of triangular co-ordinates and have adapted a statistical approach to the data from a number of areas; they have demonstrated the comparative effects of management in small or large plantations on manurial status. Halais has also emphasised the importance of adequate rainfall prior to sampling if reliable results are to be obtained.

Other leaf analysis methods

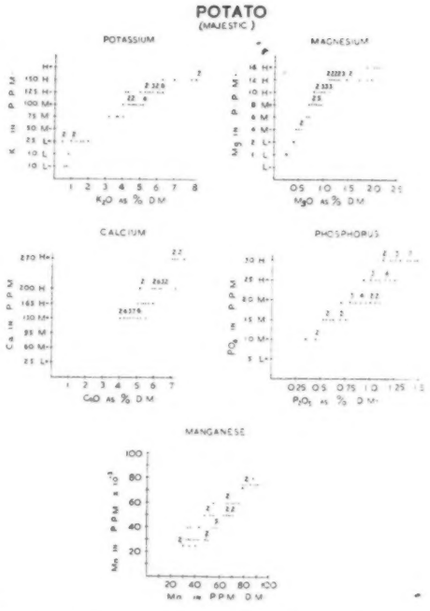
From the preceding paragraphs it is evident that foliar diagnosis is a term which has been adopted by two schools in respect of closely related and clearly defined methods of plant analysis. It is natural, however, that other workers should have devised modified procedures which diverge from the original in varying degree while others considered below represent independent attempts to assess nutrient status.

Triple analysis

In Sweden Lundegardh (1938) suggested a procedure which he termed ' Triple Analysis.' It was based originally on the idea that diagnosis of the plant's requirements could be most efficiently achieved by analysing simultaneously both the plant and also the citric acid extracts of the surface soil and (but not invariably) of the sub-soil on which it was grown. The analyses included determinations of soil acidity (pH value) and the amounts of calcium, potassium, magnesium, iron, copper and phosphate present. The work was economised by the use of a spectrographic method of analysis and the lower standard of accuracy was compensated by



Probable effect of the yield of fertilisation with 60 kg. of 40% potassium salt per acre. A low content of potassium in the leaves indicates good results, high content less good, etc. Increasing supply of phosphorus raises the utilisation of potassium (Prof. Lundegardh)



The relation between tissues tests (ordinates) and ash analyses (abscissae) for K, Mg, Ca, P and Mn in potato (Majestic). Tissue test ash analysis data in parts per million (p.p.m.) in the extract and as percentage dry matter (D.M.) respectively. Mn in p.p.m. in the extract and dry matter. Data for three seasonal sampling times are plotted irrespective of treatment. Figures above points denote the number of times values coincide

the more extensive data available for comparison. Lundegardh regards the plant as the ' ideal ' biological soil extracting agent; and certainly the idea that the plant itself should ' tell its story ' is sound.

Lundegardh subsequently modified his method in respect of the three major nutrients by confining his triple analysis to the plant only, thereby following the example of Lagatu and Maume, and of Thomas; however, he retained the soil analyses when studying elements such as iron, manganese and calcium.

Lundegardh* (1943) found that the curve obtained by plotting *increase* in yield due to fertiliser treatment against nutrient content in the leaves of plants from the control plots was approximately hyperbolic, indicating, as might be expected, that the maximum response to fertiliser application was obtained with plants which had the lowest status with respect to the added nutrient. The interaction of two elements, for example potassium and phosphorus, was depicted by plotting the curves for response to potassium at two or three different levels of phosphorus status. It was found that the lower the phosphorus status the less was the response to added potash.

Nutrient ratios and balance

Although the methods of foliar diagnosis described above depend on taking account of both nutrient ratios (quality factors) and the absolute content of nutrients present (quantity factors) their originators were not the first to suggest that mineral element analyses could be related to yields. They have, in fact, been employed since the time of Hellriegal, Atterberg, Godlewski and others, but certain special instances require further consideration.

The use of leaf analysis for the diagnosis of iron deficiency has often been attempted, but usually it has been found that the total iron content of green and chlorotic leaves bears little relationship to the condition of the plants; for example, in lime induced chlorosis Wallace found, and others since have confirmed, that the ratio K/Ca is abnormally *high* on chlorotic leaves of fruit trees, in spite of the fact that calcareous soils may also accentuate potassium deficiency.

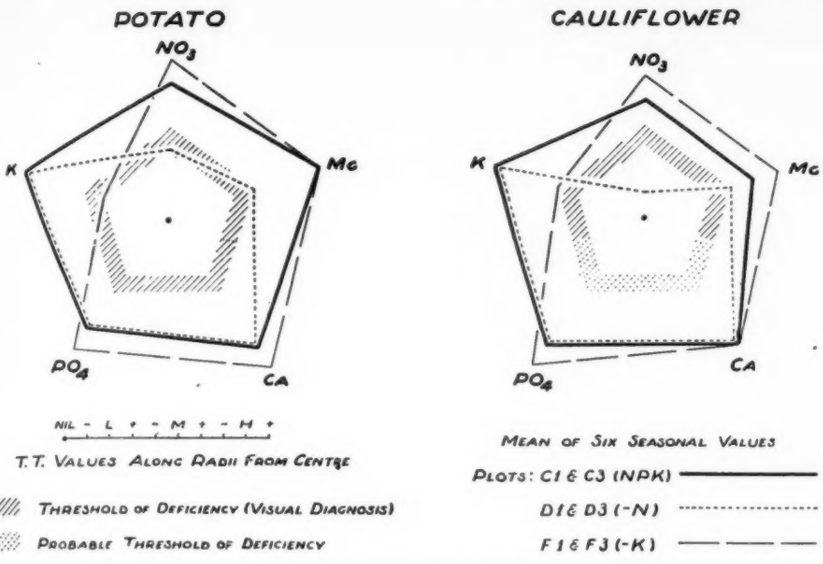
The suggestion that iron deficiency could be interpreted in terms of the man-

*Lundegardh expressed the relationship by equations as follows:—

$$\text{y.a.} = \frac{K}{x^c}$$

$$\text{and Y.A.} = \frac{K_1}{x_1^{c_1}} \cdot \frac{K_2}{x_2^{c_2}} \cdots \frac{K_n}{x_n^{cn}}$$

where y, Y are the *increases* in yield due to the addition of the nutrients. x_1, x_2, x_n are the nutrient concentrations (milliequivalents) in leaves at the time of sampling (usually flowering stage) and the indices c_1, c_2, c^n indicate the hyperbolic nature of the relatio nship. The first equation applies to the effect of a simple nutrient, and the second accounts for the product type of function due to the interaction of several.



Diagrams showing the relation between soluble K, Mg, Ca, PO_4 and nitrate N in potato and cauliflower growing under various manurial treatments. The mean of six tissues test values for each nutrient for NPK, NP (omit K) and PK (omit N) treatments respectively obtained at intervals during the season are plotted along five radii of a circle. (Results for two blocks are bulked together)

ganese/iron ratio in soya bean was made by Shive and his associates, who unfortunately inferred that it was a generally applicable rule. It has, however, since been proved conclusively by the writer and others, that iron and manganese exert independent effects in plant metabolism and that manganese toxicity is distinct from iron deficiency, although the ability of manganese to induce iron deficiency in certain circumstance is not disputed. Nicholas has also shown that the manganese / iron ratio appears to have little or no diagnostic significance under field conditions.

Threshold values and the critical percentage

The use of threshold values to denote the probable levels of deficiency, or toxicity, has been found especially useful at Long Ashton, where the work of Wallace and Nicholas has shown that the appearance of visual symptoms of deficiencies of certain elements, especially potassium, magnesium, phosphorus, manganese and boron, and of excess of chlorine and zinc and manganese are closely correlated with the threshold nutrient content of the dry material. Thus the threshold (minimum) values for apple foliage (terminal shoots late July) are given by Wallace (1947) as follows: CaO, 1.0; K_2O, 1.5; MgO, 0.40 per cent. in dry matter.

The combined use of threshold values, based on wide experience of different crops and of the soils on which they have been grown and the technique of comparison of the analysis of healthy plants with that of unsatisfactory specimens has, in most instances, provided a sound clue to the diagnosis of the trouble, especially if visual symptoms have also been observed.

The validity of threshold concentration methods of diagnosis has been strengthened by the ' critical percentage ' concept of Macy (1936). Macy tested the effects of increasing nitrogen supply on the yield and composition of barley and re-examined the data of earlier experiments. He concluded that the relation between yield, increment and composition could be expressed by a curve that could be sub-divided into roughly three sections or phases. At the lowest levels of nutrition—' the minimum percentage,' yields increased without appreciable alteration in percentage composition. In the next, the ' poverty adjustment ' phase, yields and percentage composition varied proportionately. In the third or ' luxury consumption ' phase yields did not greatly increase relatively with increases in nutrient concentration. The region of the curve representing the change from poverty adjustment to luxury consumption was termed the ' critical percentage,' and this value clearly coincides in theory with the threshold concentration. The actual transition is, however, continuous and not sudden. Macy considered that Mitscherlich's law held true over the range of poverty adjustment, whilst Liebig's law held for the region of minimum percentage and luxury consumption. Steenbjerg has recently reached a similar conclusion, but his results indicate that the nutrient concentration per cent. dry matter may actually diminish relatively with increases of yield at levels of extreme deficiency, before the features described above are exhibited. This has been termed the ' dilution effect.' The more usual range of experience in agricultural practice corresponds to the region of poverty adjustment and the transition to the phase of luxury consumption.

Additional evidence for the validity of the threshold concept may be obtained from controlled pot experiments where yields and nutrient content can be compared in relation to known levels of nutrient concentration. In such experiments, however, the possible effects of the size of the containers and other limiting factors on the maximum yields require to be kept in mind.

Fresh tissue analysis

The methods considered so far have been based on ash analysis of dry matter. In many instances, however, useful results can be obtained, with much economy of time, by estimating the nutrients in fresh tissues. The so-called tissue test technique, based on semi-quantitative colour tests, was initiated by Hoffer and Thornton at Purdue University, Indiana, in 1926.

In this work non-woody tissues abundantly provided with conducting elements—for example petioles—were chosen as capable of indicating in a satisfactory manner the demand for nutrient elements by the plant. Since this early work many techniques for conducting the tests have been devised; particular mention must be made of the use at Long Ashton by Nicholas (1944 onwards) of Morgan's sodium acetate-acetic acid buffer solution (pH 4.6) to extract nutrients from petioles or foliage for *quantitative* determinations of the readily soluble nutrients, and of the employment of N/10 HCl by Oserkowsky in 1933, to extract what he termed ' active ' iron from green and chlorotic leaves. The latter was one of the first attempts to correlate the total iron present in leaves with their chlorophyll content. Other methods suggested for this purpose include the use of alcohol, acetone, acid-ether and concentrated hydrochloric acid for tissue extracts. All of these extractions, however, leave much to be desired and the problem of finding a reagent that will extract an iron fraction from leaves which invariably reflects its activity in chlorophyll formation under conditions of iron deficiency, needs further investigation.

The methods of Nicholas have been applied extensively to a wide range of crops including potato, tomato, *Brassicae*, cereals

'roots', legumes and fruit. Greatly increased accuracy has been obtained by the use of rigorously standardised sampling and extraction procedures by the employment of the photo-electric absorptiometer or Lovibond tintometer standards in making the tests and establishing good correlations with total analyses. Standards have been set up after extensive experiments which enabled yields, fertiliser treatments and visual effects of deficiencies or excesses to be correlated and the method has been applied to the examination of numerous advisory problems. The values obtained have been compared with the results of total analysis of the same samples at frequent intervals in the season and good correlations obtained, especially in the case of potassium, calcium, magnesium and manganese. The agreement is closer for low and medium categories than for the high ones where saturation effects occur and the soluble fractions ' tail off ' relative to the total ash fractions. Thresholds of deficiencies indicate concentrations that coincide with or slightly anticipate the appearance of visual deficiency symptoms.

It has been suggested that whereas foliar diagnosis methods indicate both ' assimilated and unassimilated ' nutrients, tissue test methods reflect only the status of the unassimilated ones. This, however, may not be entirely true, especially when leaf homogenate methods are used, as we do not yet know the source of the nutrients extracted; it is also probable that the inferred ' readily soluble ' fractions may prove to be a more reliable guide to nutrient status than the total fractions in some instances.

Sampling plant material

The sampling procedure varies according to the crop. In Nicholas's methods petioles are used for diffusion extraction and laminae for extraction with homogenisers and for total analyses. The leaf chosen for the determination is usually a mature but not a senescent leaf, corresponding to the ' first upright leaf ' in *Brassicae*, ' mid stem ' leaves for tomatoes or potatoes, and top internode and leaf base combined for cereals. This method of sampling differs therefore from that of the foliar diagnosis school in progressing upwards with the age of the plant; it represents, however, comparable physiological material at each point in relation to age. Wherever possible, healthy and abnormal materials are both sampled for comparison. A number of factors influence the choice of material. In the first place there is a gradient in nutrient composition from one part of the plant to another, the direction of which depends on the particular nutrient concerned. Calcium and boron tend to accumulate in older leaves and deficiencies are reflected in low concentrations in the youngest foliage. Magnesium, potassium and phosphorus on the other hand are translocated from old to young leaves and, when deficiency supervenes, the gradients for these elements are the reverse of those of boron and calcium. Under conditions of ' luxury consumption ' and in certain other circumstances the potassium gradient may, however, be reversed. The intensity of the gradient also depends on age and is usually accentuated in older plants. These effects make the rigid adherence to a specified sampling procedure of the utmost importance. It is usually considered that actively metabolising leaves, neither senescent nor rapidly expanding, present the best compromise. Such leaves are conveniently designated ' mid-stem,' ' mid-crown ' or ' first upright ' leaves.

Leaves are the organs usually sampled since they are the principal sites of growth processes and metabolic activity, but for some purposes, for example the determination of readily soluble nutrients, the conducting regions (stems and petioles) are preferred. Fruits and seeds tend to accumulate nutrients relative to other parts of the plant, especially under deficiency conditions, and are therefore less sensitive. Roots are inaccessible and contaminated by soil, but in special circumstances may indicate an abnormal nutrient status.

Weeds as pointers to soil fertility

The use of weeds as an index of soil fertility was suggested by Hall but has not been widely exploited. The ecological relationships between the occurrence of weeds and the acidity of the soil is useful in helping to forecast whether a soil is acid or alkaline. *Rumex acetosella* is common in acidic arable land and the relationship of *Astragalus spp.* to seleniferous soils is well known. Weeds may also indicate magnesium deficiency. Goodall has recently carried out the analysis by weeds a stage further by comparing the potassium and manganese status of certain weeds to the requirements in this regard of barley or wheat. The general conclusions were not, however, promising.

Advantages and limitations of the methods

The original foliar diagnosis method possibly attached too great significance to nitrogen, phosphorus, potash, calcium and magnesium without having due regard to the effects of micro-nutrient deficiencies or excesses, or other nutrient relationships. This was due partly to the adherence to the triangular method of presentation and partly to failure to recognise the great and varied influence of the micro-nutrients.

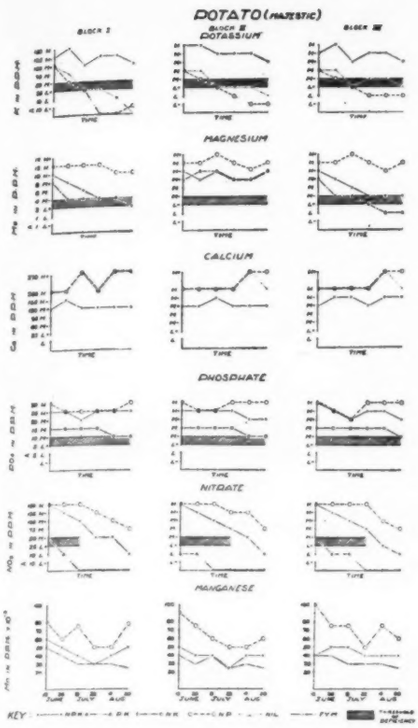
On the other hand foliar diagnosis methods can show in a single diagram the seasonal trends of the NPK or K Ca Mg units, but neither the trend nor the locus of the units by themselves indicate whether the nutrient status corresponds to optimal balance or to a nutrient disorder unless corresponding data for high yielding plants are also included.

Presentation of results

It has been customary to express nitrogen and the major mineral nutrients in terms of percentage of dry weight. Micro-nutrient elements are, however, often given as parts per million of the element. In time it may be considered more consistent and logical to express each element in the same terminology, for example, milligram equivalents.

Unit leaf weight, fresh weight, sap concentration and protein content have also been used as reference points. Protein content may possibly have merits as a basis for calculation where special problems of nitrogen assimilation are involved, but it involves an additional determination.

The inter-relationships of mineral nutrients have been well brought out by Nicholas in diagrams where the concentrations of the various elements are plotted along the radiating ' spokes ' of a polygonal figure. Theoretically there can be as many ' spokes ' as there are influential elements, but the data so far have only taken into account the effects of N, P, K, Ca, Mg and Mn. It is possible from experience with manurial trials and yield data in relation to the composition of crops from different centres to infer the concentration of these elements that correspond to normal growth and high yields and also to deficiency thresholds. The diagrams are constructed so that the healthy plant is represented by isometric ' spokes ' for each element, which give a *regular* figure. Intensity factors are indicated by lengths of 'spokes' and quality by the outline of the figure. At some distance within this periphery lies the deficiency threshold region and the unsatisfactory nutritional state is readily seen by the distortion of the outline due to the unequal ' spokes.' Thus low nitrogen status is also often accompanied by low magnesium status. The type of polygon produced is characteristic and readily recognised. Low potassium is generally accompanied by higher calcium, magnesium or phosphorus status shown by longer ' spokes.' This approach possesses two great advantages over that of the foliar diagnosis schools. First, it can account (in



The seasonal trends of soluble K, Mg, Ca, PO_4, nitrate N and Mn in potato (Majestic). The following treatments are shown: NPK, Nil, NP, PK and NK. The shaded areas represent the threshold ranges associated with visual signs of deficiency

course of time) for all the known essential elements and, second, it illustrates malnutrition both in intensity and balance and not merely a particular combination of N P and K as a locus in a triangular co-ordinate system. Seasonal trends cannot be shown simultaneously for so many elements, but this is readily overcome by the use of separate or possibly superimposed diagrams prepared with rectangular co-ordinates.

Conclusions

The use of leaf analysis methods for the determination of nutrient status and requirements evidently presents a number of problematic features. In addition to those discussed, climatic and varietal factors, soil structure and moisture capacity may also influence the interpretation of data.

The extension of foliar analysis for diagnostic purposes to the estimation of the fertiliser needs of crops is still more difficult, and there is scope for much research on the relation between nutrient composition, yields and fertiliser response. The problem is complicated by the greatly differing powers of soils to fix nutrients and the effect of these on nutrient availability. pH values and liming also greatly modify the response to fertiliser treatments as has been shown by Wallace and others in regard to the effects of manurial treatments on the visual symptoms of mineral deficiency as well as on the yield and composition of potatoes grown in leached acid soils.

The limitations of soil analysis cannot be considered in this discussion, but it is suggested that the diagnosis of fertiliser requirements necessitates consideration of the soil conditions as well as the nutrient status of the plant, inasmuch as analysis of the plant alone cannot indicate intensity of fixation. The methods recently developed in regard to maize by Prof. Roger Bray of Illinois, are an interesting approach to this aspect. He claims that by using certain novel methods to determine soil nutrient fractions reasonably close correlations can be established with yields. The principle on which the method rests is that a soil test should indicate the whole or a *constant fraction* of the totally available nutrient, irrespective of soil type. By expressing yield as a percentage of a possible maximum and determining the values for both available phosphorus and potassium, the required amounts of these elements appear capable of independent prediction with fair precision. Extension of this procedure to include crop analysis should enhance the reliability of these predictions and would imply a return to the triple analysis concept of Lundegardh.

BIBLIOGRAPHY

R. Bray: In 'Diagnostic Techniques for Soils and Crops,' p. 53. Edited by Hermione Kitchen for The American Potash Institute, Washington, 1948.

D. W. Goodall: *Annals of Applied Biology*, 1949, **36**, 268, 352.

D. W. Goodall and F. G. Gregory: *Chemical Composition of Plants as an Index of their Nutritional Status*. Commonwealth Bureau of Horticulture Technical Communication No. 17, 1947.

H. Lagatu and L. Maume: *Compt. Rend. Acad. Sci.* (Paris), 1924, **179**, 782; 1937, **204**, 535; 1937, **205**, 549; *Compt. Rend. Acad. Agric.* (France), 1934, **20**, 246.

H. Lundegardh: *Soil Science*, 1938, **45**, 447; *Nature*, 1943, **151**, 310.

P. Macy: *Plant Physiol.*, 1936, **11**, 749.

D. J. D. Nicholas: *Long Ashton Res. Sta. Ann. Rept.*, 1944, 84; 1945, 60; 1948, 98.

J. Oserkowsky: *Plant Physiol.*, 1933, **8**, 449.

W. Thomas: *Plant Physiol.*, 1937, **12**, 571; *Proceedings American Society for Horticultural Science*, 1937, **35**, 269; *Soil Science*, 1945, **59**, 353.

W. Thomas and W. B. Mack: *Proceedings American Society for Horticultural Science*, 1939, **37**, 253; 1944, **44**, 355; *Soil Science*, 1943, **56**, 197.

T. Wallace: *The Visual Diagnosis of Mineral Deficiencies in Crops, a Colour Atlas and Guide*, H.M.S.O., London, 1947-1948.

T. Wallace *et al.*: *Long Ashton Res. Sta. Ann. Rept.*, 1946, 61; 1947, 97.

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Biological Control of Insect Pests

Southern corn rootworm

A new survey of insects, parasitic and predatory, on the southern corn rootworm was recently carried out by Dr. W. D. Fronk of the Virginia Agricultural Experimental Station. Previous research in 1947 showed only two natural enemies of this pest—the tachinid *Celatoris diabroticae* and the nematode *Howardula benigna*. The new survey has unearthed a few more. These include three nematodes and five kinds of beetle (species of *Xantholinus*, *Agonum*, *Amara* and *Anisodactylus*). However, only the original tachinid and nematode were able to control the pest satisfactorily, although the others are undoubtedly a factor.

Mealy bug on pear trees

A useful method of controlling the mealy bug (*Pseudococcus maritimus*) on pears is reported by the University of California. In the Santa Clara valley, it appears, the natural enemy of this pest is the lace-wing fly *Chrysopa californica*. Complete control was obtained by supplying artificially produced eggs to pear orchards. Although the trees had been sprayed against codling moth, the predator larvae were in no way inhibited, and they fed actively on the mealy bug population of the affected trees.

It was found that the time of egg colonisation was extremely important if effective control was to be obtained. The usual routine was to place a batch of about 250 eggs in the crotch of each tree at a time so that the larvae would develop while the immature stages of the first generation of the pest were on the trees. This treatment gave best results when repeated at two successive intervals.

Another interesting facet to this research is that once the mealy bug is suppressed by *Chrysopa californica*, the pest population remains economically low for about two years.

Chemical dangers

One of the doubts about chemical control that is at the front of some of our minds is put into concrete form by the work carried out recently at the Bato range in Louisiana. Here it was found that BHC, DDT and *Toxaphene* all seriously reduced the population of predators of the cotton aphid, bollworm and spider mites in field trials. The newer organic insecticides, it is alleged, were more detrimental to these beneficial insects than even calcium-arsenate-nicotine.

The Coffee Industry

A Review of World Production

IN view of the recent spectacular rise in the price of coffee, a review of some of the chief points of the world production of coffee is of interest. The rise is accounted for by the remarkable change which has occurred in the supply and demand position during the last few years. Formerly coffee was in excess supply and this led to conditions of crisis in all producing countries. Now the position is completely changed and in place of coffee production exceeding consumption the reverse is the case.

The change is due to two causes; firstly, available supplies of coffee have considerably diminished and, secondly, the demand for coffee has steadily increased. Before the war, world consumption of coffee was 20% below world production; it is now, however, rated at 7½% above it. In America, for example, consumption has increased by 50% in the last ten years. The table below, taken from data provided by the Inter-American Coffee Bureau, shows the trend of coffee production and consumption between the years 1936-7 and 1947-8, and aptly illustrates the position.

Coffee has for many years suffered from overproduction, and conditions in many of the coffee producing countries have in consequence been depressed. Latterly, however, the position has changed and, for the first time for many years, supply has been overtaken by demand. Some of the salient features of the present production position are reviewed below.

On the long-term view world coffee production shows on balance a decided upward trend within which, however, there are numerous fluctuations, periods of decline alternating with increased production, the alternations being dictated by price fluctuations; a marked upward trend is followed by increased plantings. Up till very recently prices have been low and the trend has been downwards. A rise may now be anticipated but as coffee trees take four to five years to come into full bearing, increased production resulting from increased planting must always show a time lag; it is not to be expected, therefore, that any marked increase from this cause will manifest itself for several years to come; under the stimulus of high prices, however, some increase is likely to occur through the rehabilitation of neglected and abandoned areas. An additional factor is the growing scarcity and dearness of labour which also tends to decrease production. The trend of consumption and production of coffee during the present century is illustrated by Fig. 1.

WORLD PRODUCTION AND CONSUMPTION OF COFFEE BEANS IN 1,000 BAGS

Crop Year	Production		Consumption		
	Brazil	World	U.S.A.	Britain and Europe	World
1936-7	26,359	37,248	12,349	11,206	24,886
1937-8	23,579	33,590	12,565	11,948	25,472
1938-9	23,300	33,425	13,817	10,819	26,727
1945-6	15,266	27,744	20,373	4,350	26,500
1946-7	13,965	27,000	19,285	5,500	27,000
1947-8	13,353	27,653	20,234	7,000	29,760

Note.—The crop year runs from July 1 to June 30.

Coffee terraces at Cambuhy in the State of Sao Paulo, Brazil

Sources of supply

Coffee is today pre-eminently a product of the Western world, and the bulk of the world's supplies come from South and Central America. It is somewhat curious that this should be so since the coffee plant is indigenous to the eastern tropics and was introduced to the Americas in the early days of colonisation. Fig. 2, based upon pre-war export figures, illustrates the dependence on American supplies, although this needs some qualification since in most countries where coffee can be grown large and often unascertainable quantities are consumed locally.

There are a number of species of the genus *coffea* and upon the kind cultivated the quality of the product in large measure depends; it is also largely influenced by the care taken in its preparation.

The three main types are Arabian, Liberian and Robusta. Arabian coffee, derived from *Coffea arabica*, is by far the best in quality, but the cultivation of other varieties has been extended because of the proneness of Arabica to disease and also because it requires to be grown at elevations of 2,000 to 5,000 ft. Liberian and Robusta, derived from *Coffea liberica* and *Coffea robusta*, are coarser in quality, more resistant to disease and can be grown at lower elevations. Nevertheless Arabian coffee still constitutes the bulk of the world's supply.

Bourbon Vermelho coffee, showing berries. This is a special high-yielding Bourbon coffee

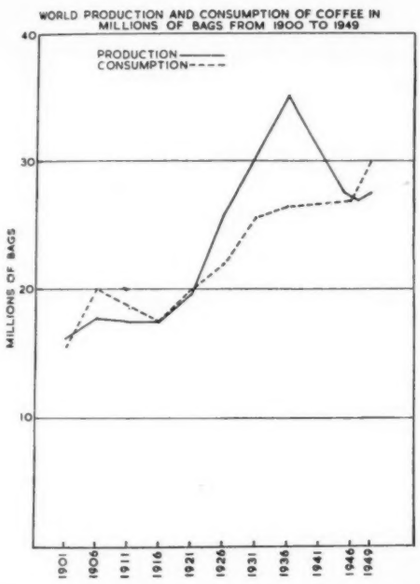

Fig. 1.—The trend of consumption and production of coffee during the present century

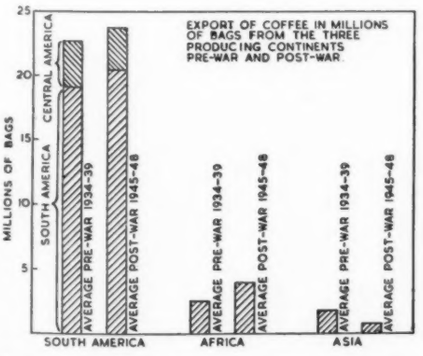

Fig. 2.—This shows how dependent the world is for its coffee upon S. and Central America

Coffee is divided by the trade into two sharply-defined classes; Brazilian coffees, or hard coffees, and mild coffees, corresponding to very marked differences in quality and flavour. Typical Brazilian coffees tend to be strong and coarse in flavour, while mild coffees are sharp rather than strong. The difference however does not appear to be due simply to variety since nearly all the coffee grown in Brazil seems to be derived from two very similar races of Arabica; rather does it seem that the characteristics which distinguish the hard Brazilian coffees from the mild coffees of Colombia, Central America and other parts of the world are due primarily to differences in preparation.

The Western hemisphere

Coffee production in the Western hemisphere is confined to the South and Central American regions and to the islands of the West Indies. Tropical South American production for export is derived from Brazil, Colombia, Venezuela and Ecuador. The crop is, however, grown to a greater or less extent in a number of other countries, but apart from small quantities which are exported the whole production is consumed locally. Brazil is by far the largest producer, the exports having averaged roughly 900,000 tons annually over a long term of years; Columbia comes next with an average annual export of approximately 300,000 tons, followed by Venezuela with approximately 35,000 tons and Ecuador with 10,000 tons.

In central America coffee is an important item of export from practically every country, the largest producer being El Salvador with an average export of 58,000 tons followed in descending order by Mexico, Guatemala, Costa Rica, Nicaragua and Honduras. In the West Indies Haiti is the largest producer with an average export of 25,000 tons, while smaller quantities are exported from Cuba, Jamaica, Guadeloupe and Trinidad.

Hard coffees are produced in Brazil, but from the remainder of the countries of this region the production mainly consists of mild coffees, and some of the finest coffee in the world comes from the Central American region.

The difficulties encountered of late years owing to excessive production have led to a much greater degree of organisation of the industry. The lead was given by the United States of America, at whose instigation the Inter-American Coffee Bureau was established. Coffee departments, or boards, have now been established in practically all of the South and Central coffee-producing states with the object of improving the quality both by grading and research. They also regulate exports to determine minimum prices at which coffee may be exported.

A Coffee Growers' Federation has been established for Central America and Mexico, membership of which includes all the coffee-producing states in this region. It holds annual meetings; the 1949 meeting was held in Guatemala.

The position in Brazil

Coffee is the mainstay of the Brazilian agrarian economy and the share of the commodity in the total value of exports amounts to 40%. It is stated that there are upwards of 2,150,000,000 coffee trees in production and that they cover an area of more than 6,000,000 acres. For many years production greatly exceeded exports but of late years it has diminished and has fallen from 26,000,000 bags pre-war to about 14,000,000 bags in the post-war period.

To deal with the pre-war situation large quantities of coffee were burned but there were, however, still very large carry-over stocks. Even in July 1949 it was estimated that these still amounted to about 8,000,000 bags; since then, however, it is reported that the Brazilian Government has liquidated remaining stocks and it would appear that the surplus which previously influenced the market may no longer exist. Latterly, in view of rising prices, exports have tended to rise; for 1948 they amounted to approximately 17.5 million bags and for the current year they are estimated at something less than 16,000,000 bags.

The total domestic consumption of coffee in Brazil is estimated to be approximately 5.3 million bags, of which about 3.3 million bags are consumed in the in-

terior without being despatched to the ports.

In view of all this the prospects are for considerable short-falls in supply unless production again expands.

Coffee is produced in nine states of Brazil of which by far the most important is Sao Paulo, accounting for roughly 50% of the total production. The remaining important producing states are Minas Gerais, accounting for one-sixth production, Espirito Santo for one-eighth production and Parana for one-ninth production; the remainder is produced in the five states Rio de Janeiro, Bahia, Pernambuco, Goyaz and Mato Grosso.

Bushes of Bourbon Vermelho coffee; photo taken two and a half years after they were planted out in the field

Coffee in the Eastern hemisphere

I Asia

Coffee is produced in many countries of Asia, while African production is increasing steadily. Prior to the war the most important exporter in Asia was Indonesia, which annually exported somewhere in the region of 1,961,000 bags. The effect of the war and the Japanese occupation has been greatly to reduce production, which is, however, now reported to be slowly improving. For 1950 the coffee harvest in Indonesia has been officially placed at 580,000 bags of 60 kilos, but this is considerably lower than the annual average pre-war output of 1,961,000 bags and little is expected to be exported. The bulk of the crop is derived from Robusta coffee, which represents about two-thirds of the total production, the remainder being Arabica.

Elsewhere in Asia the most important export producer is British India, notably the state of Mysore, where production is stated to be steadily increasing. Pre-war the annual exports amounted approximately to 15,000 tons. The total area under coffee in India is estimated at 222,000 acres of which 167,000 are Arabica and 55,000 Robusta. The internal consumption of coffee throughout Asia is steadily rising and unless the world shortage stimulates greatly increased production it seems likely that it will become a diminishing factor in world supplies.

II Africa

After America tropical Africa is now the most important source of export production. The coffee tree is a native of Abyssinia and coffee drinking has been traditional in parts of Africa for many hundreds of years. Export production is increasing from a number of areas; the crop is grown for export in British, French and Belgian territories as well as Madagascar. In East Africa it is an important item of export from Kenya, Tanganyika and Uganda; in West Africa from French territories, while production in the Belgian Congo is also considerable.

East Africa

Pre-war the average total production of coffee in East Africa was 785,000 bags, and this is showing a tendency to rise; for the year 1948 total export production was over 1,000,000 bags. A breakdown of British East African coffee exports for that year by colonies shows that Uganda leads with 640,000 bags, followed by Kenya with 234,000 and Tanganyika with 202,000 bags. Production consists partly of Arabica and partly of Robusta coffee. The great bulk of the Arabica is produced on European estates and the Robusta on smallholdings owned and worked by African natives.

Considerable efforts are in progress to improve production both on estates and on native-owned smallholdings. Two research stations exist, the work of which has influenced the industry considerably, while the preparation of the crop for market has been greatly improved. Marketing is well organised and growers associations exist for the protection of the interests of large and small growers. The position of the industry was discussed in an article in WORLD CROPS, Vol. 1, p. 152.

West Africa

In French West Africa coffee production is also considerable. Total production for 1949 was officially estimated at 950,000 bags, of which 750,000 bags were exported. It is further estimated that for the current year exportable production may be as high as 960,000 bags, *i.e.* over four times the pre-war average 1935-40 which amounted to about 210,000 bags. The exports were formerly restricted to Metropolitan France and the French Colonies, but since February 1950 control of exports has been removed. The total area under coffee in French West Africa is estimated to be 425,000 acres of which 20% are under plantations owned by Europeans and the remainder is owned by natives. More than 90% is produced in the Ivory Coast, the balance being grown in Dahomey and French Guinea. Robusta coffee accounts for 80% total shipments. Arabica, Kouilou and Assikasso are the other varieties grown.

Many measures are being undertaken to improve coffee cultivation in French West Africa. Research conducted by the experimental station at Bingerville is expected to improve yield and quality in due course.

The Belgian Congo

In 1949 the Belgian Congo, which includes the trust territory of Ruanda-Urundi, produced a total of 535,000 bags of coffee for export from an area of about 170,000 acres. This included 335,000 bags of Robusta and 200,000 bags of Arabica coffee. Over three-fourths of Arabica is produced in Ruanda-Urundi.

Of the exports the largest quantity went to Belgium which took the bulk of the Robusta coffee, the principal market for the Arabica being in the United States. About 100,000 bags, however, went to the United Kingdom.

Madagascar

Coffee is also an important export from Madagascar. Pre-war production was 537,000 bags; since the war production has declined somewhat, thus in 1947 it amounted to 317,000 bags; in 1949 it

approximated to 450,000 bags, an improvement on previous years but still below pre-war production.

Conclusion

The foregoing outlines some of the features of the present international coffee situation. Under the influence of rising prices and a greatly improved stock position it may be anticipated that coffee production will in due course once more expand, but this may take some time and the immediate outlook seems to be for shortages.

In many countries increased provision is being made for research and this too should in due course have its influence in increasing production. It is already clear that improved cultivation, pruning and manuring can bring about considerable increases in yield, while the production of disease-resistant strains and measures for the control of pests and diseases should also have an important effect.

Improvement of quality is also of great importance, and although quality is undoubtedly affected by the type of coffee grown, it is even more influenced by care and the use of improved methods of preparation. The development of research may be expected to bring about improvement in this direction also.

Equally on the economic side the introduction of greater control over production and marketing seem likely to play an increasing part.

It would seem that the industry is now in a fair way to being relieved from the burden of over-production and heavy accumulated stocks which have had so detrimental an effect in past years, and the future outlook is promising from the producers' point of view.

The information on which this article is based is mainly derived from various official publications. Acknowledgment is also made of information concerning the Brazilian industry supplied by Senor Caio de Freitas of the Brazilian Government Trade Bureau in London.
(*Photos: Cambuhy Coffee and Cotton Estates Ltd.*)

Aerial Top-Dressing Trials

Demonstrations over the Welsh Hills

Following last month's account of experimental aerial top-dressing in New Zealand we now publish a description of similar work recently carried out over the hills of Wales, marking the latest developments in an operation which appears to hold out great hopes for increasing the grazing capacity of otherwise inaccessible hill country.

THE first full-scale public demonstration of its kind to be held in the United Kingdom took place at Plynlimon, Cardiganshire, on the land of Capt. G. L. Bennet-Evans, when a 'Bristol' freighter dropped about 40 tons of fertilisers in eight sorties during the two-day demonstration organised by the Bristol Aeroplane Company in conjunction with the *Farmers' Weekly*. This was the first time a large aircraft capable of carrying 6 tons of material had been used for this work; in New Zealand a modified Grumman Avenger torpedo bomber carrying about 1 ton had been employed.

With the Welsh hills spreading out below, the freighter is seen beginning to drop its load of 5 tons of lime

The freighter had a large fuselage cubic capacity and was able comfortably to accommodate a three-hopper installation carrying 6 tons of material. Loads greater than this would have probably necessitated the use of a multi-engined aircraft with its attendant high-operational cost and inability to operate from a grass aerodrome and landing strip. By using three two-ton hoppers simultaneously, with exit-holes at the widest settings, a very high density rate per acre was obtained. The material to be distributed was fed by gravity into the hopper through ducts having openings in the roof of the aircraft. Bucket-type shutters opened at the exit holes to allow the contents to be discharged, and their operation was by a simple lever principle operated by a bar across the width of the hopper which was pressed down to open the shutters to any required dimension from 3 in. to 10 in.

Dropping rates and accuracy

At Plynlimon pelleted superphosphate was dropped at rates of 2, 4 and $5\frac{1}{3}$ cwt. per acre, nitro-chalk at 2 cwt. per acre and lime (CaO) at 15 cwt. per acre. The accuracy of the drops was reported as being very impressive and a satisfactorily even distribution was obtained. The demonstration was concerned merely with the physical and not the economical aspect of aerial top-dressing, and the freighter's base for re-fuelling and re-loading was about 90 flying miles away. For actual operations aircraft would be based about 25 miles from areas to be treated, with consequently more rapid and frequent sorties. With an average radius of action

A Welsh farmer stops to examine the lime pellets

of 30 to 40 miles, a freighter can carry out 12 sorties in a normal day's operation. Covering 60 acres at each sortie at a rate of 2 cwt. per acre, one aircraft could top-dress 180,000 acres during a year quite easily.

Costs

Estimated operational costs have been worked out, based on the Society of British Aircraft Constructor's formula which assumes an annual average of 1,500 flying hours. In a passenger-carrying capacity the cost of the freighter is £50 an hour, and so it is reasonable to assume that for agricultural purposes the direct operating costs can be reduced to between £40 and £45 per flying hour. At £45 per flying hour this works out at 7s. 6d. per acre, or £3 15s. 0d. per ton of phosphate distributed, not including the cost of material distributed. Bearing in mind that this type of work will be carried out over land on which it would be impossible or impracticable to employ conventional methods, the cost is not high. In any case, there is a substantial Government subsidy for hill land farmers in the United Kingdom who, in the case of lime, receive half the cost of material and a proportion of the spreading cost as well.

Ground-air contact

It was apparent from the demonstration that the ground operator was the key man who maintained contact with the aircraft by using a 'walkie-talkie' ground control radio; it was he who 'talked in' the freighter, guided it into the correct line of flight and gave the signal to release the fertiliser.

The sizes of the burnt lime chippings (88% CaO) were considerably greater than those of the granular fertilisers, being about ½ in. in diameter, but they fell to the ground as evenly as the other materials. The nitro-chalk was not pelleted, yet distribution was as good as that obtained with the granular phosphate.

Potentialities

Now that the practical possibilities of aerial top-dressing have been proved and demonstrated, it remains to be seen whether public or private enterprise will utilise this new method of increasing productivity and open up the hills to more sheep and cattle.

The cost of a freighter (£60,000) would be prohibitive to even the largest hill farmer in the U.K., and it would appear that the most economical way of doing the work would be by some form of contract service. The best and cheapest method of working is for large blocks of land to be top-dressed, probably entailing several farms, and the farmers concerned would have to get together and agree on apportioning the cost amongst themselves. In this way an area of, say, 10,000 acres could be limed or otherwise top-dressed in a matter of four weeks.

Meanwhile further research into the work is going on and it is to be hoped that soon the hills will be able to benefit from the work that has been going on in this country and New Zealand to improve and ultimately perfect the technique of aerial top-dressing.

COMPLIMENTARY COPIES

Many readers have sent their copies of WORLD CROPS to friends. We will be very pleased to send complimentary copies if readers will kindly give the names and addresses of those whom they think would like to see the journal.

Maleic Hydrazide as Growth Inhibitor

Results from experiments on a variety of plants have shown that maleic hydrazide exerts a selective herbicidal and growth inhibitory effect. In an article appearing in the American journal *Agricultural Chemicals* (May 1950) John W. Zukel gave an account of some of his own greenhouse and field plot experiments. It was found that tomatoes, when sprayed with a 0.25% concentration of maleic hydrazide, absorbed about one-third of the chemical within 18 hours after application. Two identical rows of tomatoes were sprayed a month after planting, when green fruits were present, at dosages of 0.03% and 0.3%. It was found that the higher concentration caused the fruit to mature earlier, but the total yield was less than from untreated plots. The lower concentration had no apparent effect on foliage growth or yield and the tomatoes were normal in appearance.

Sprout suppressor

Experiments with potatoes indicate that maleic hydrazide might be useful as a preventive against sprouting during storage. The chemical was applied at six strength levels, ranging from 0.007 to 0.3%, to seven-week-old potato plants, and tubers were collected from the plot treated at 0.03%. These were stored at room temperature for five months and no sprouts developed, whereas considerable sprouting occurred among tubers from untreated plots.

Timing growth

Experiments with raspberries and strawberries indicate that maleic hydrazide might be useful for timing the development of some crops, since treated raspberry plants fruited 16 to 23 days later than untreated plants and delayed blossoming of strawberries was also effected.

Treatment of a sward composed of Kentucky blue grass, chewing, alta and creeping fescues, Astoria bent, red top and perennial rye grass, when the plants were 2 in. high, resulted in a complete kill of the rye grass within one month with no apparent effect on the other varieties.

Conclusions drawn from many experiments by Zukel and others point to the fact that young plants are more susceptible, although older plants may fail to develop seeds or rhizomes and show less effect on vegetative growth. The chemical appears to be translocated to affect different tissues either temporarily or permanently, depending on the dosage used.

The Small Tropical Farm and Mechanisation

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AGRICULTURAL mechanisation is extending quickly in the tropics on a plantation or estate scale, but amongst peasants and small farmers the machine is still a rarity. The starting point in mechanisation is usually regarded as the provision of a mechanical source of power. The very word has come to imply this although, strictly, any mechanical means of implementing operations, whatever the source of power, should be regarded as mechanisation. The hand hoe, the bull plough and the tractor-mounted plough represent levels of mechanisation, and there is room for improvement at each level of either the implement or the method of using it or both.

Several authorities have discussed the social and economic problems that may arise when machinery is introduced to a peasant area, but little attention seems to have been paid to the agricultural and engineering aspects. The development, production and marketing of agricultural machinery is costly, especially in relation to the low selling price which is so important in the agricultural market. Farmers' requirements of machinery are affected by such factors as fluctuations in world trade, localised economic conditions and local fiscal legislation. Every specification cannot be met, and in the interests of cheapness the engineering industry must confine itself to the production of a few well-established types of machine.

Taking a world-view, serious deficiencies exist amongst small tractors. This is probably due to the very varied agricultural systems in which they might be expected to work and to the difficulty of achieving low-cost production for such an uncertain market as that of the world smallholder.

If it be accepted that the main object in mechanising the tropical peasant is to increase his production rather than to reduce his costs chargeable as 'labour,' the problem becomes more resolved. Every piece of equipment must enable him to produce more food or raw material and to continue to produce more indefinitely. Where land is limited the machine must enable the farmer to produce more per acre. Where

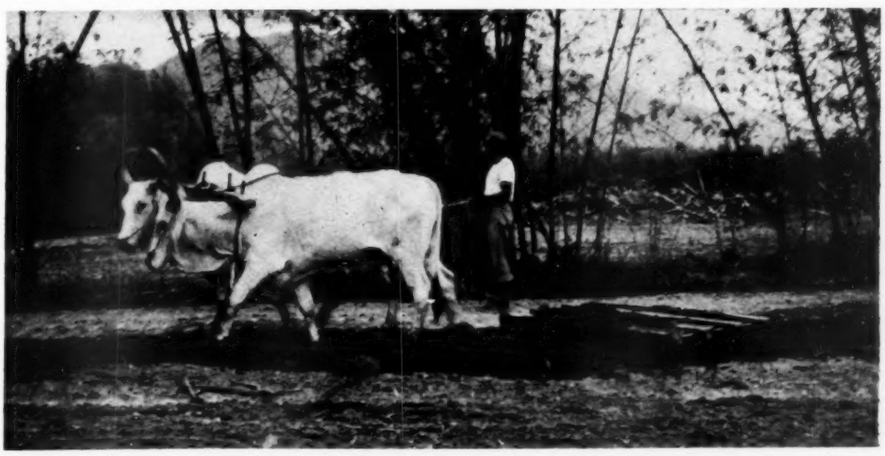
Mechanisation is the farmer's most powerful weapon for increasing output and saving labour. Nevertheless it has its limitations, particularly when it is a question of its introduction into the farming economy of primitive peasant cultivators in the tropics. The author discusses the question below.

'new' land is available the production of more per man hour is the easier course; but, taking the long view of world resources, this can only be an expedient.

Market garden tractors

A group of smallholders of relatively great economic strength is that of the market gardeners and growers, especially those of the temperate countries. Manufacturers have found it possible to design and build small tractors especially suited to their needs. It has been suggested, quite naturally, that with the economic development of peasant areas, especially in the tropics, there would be an increasing demand for these small tractors and their associated implements, but attempts to introduce horticultural tractors and implements to the tropics are meeting very limited success. To some extent failure is due to a lack of appreciation of the factors which reduce the overall efficiency and suitability of horticultural tractors on tropical smallholdings.

Where animals may be displaced there arise questions of soil fertility and the place of the dual or triple purpose animal in the farming and social system. Speedy power cultivating and planting at the correct season may result in yields very significantly higher than those obtained after slow animal work, but in wet countries the machine may not be able to work where men and animals can move without difficulty. Mechanical power may make possible a rotation of crops where previously the necessary cultivations were either too expensive or too laborious, but it is likely—at the peasant scale—to be more expensive than animal power. Mechanisation can only go as far as roads and communications will permit. Not only must the machine be able to move about but a steady supply of fuel, lubricants and parts must be delivered at an economic price, and in order to pay for the equipment and supplies considerable quantities of produce must be exported. Animal power is self-contained in so far as the fuel can be



Two oxen can conveniently pull about 300 lb. in draught, developing about 1¼ h.p. A wooden harrow at work on light land in Trinidad

found or produced locally. Moreover, it can appreciate both in cash value and reserves of power, while a machine can only depreciate.

Limitations

A machine designed primarily for a temperate agriculture is expected to work under more favourable conditions than a machine designed for the tropics. It is subject to less corrosion and depreciation, it has a lower power requirement for cultivation, it is required to work in much less rugged conditions with better repair facilities close at hand, frequently its fuel is cheaper, and the operator is expected to be more vigorous than the ordinary inhabitant of the tropics. In general in the tropics the machine must work on soils of rougher tilth, often containing in or on the surface trash, weeds and solid obstructions.

A machine designed for a developed agriculture is likely to be more successful than a machine designed for a primitive agriculture. The higher capitalisation of farming makes for easier purchase, better trial and more careful operation. Farms are usually larger (or more intensive) and therefore machines are more easily absorbed. Consumer research and relations are more effective and spare parts, fuel and machines can be more easily transported. Agricultural land is likely to be conveniently laid out and the operators are likely to be more intelligent. The farmers are more likely to be prepared to try something new and some crops may have been suited to mechanisation by selection, breeding or the standardisation of cultural practices.

A machine designed for horticulture is unlikely to be fully adaptable to a non-horticultural holding because horticulture is usually practised on a level, well-drained, tractable soil, and the horticultural market tolerates specialisation of purpose and design. The operations, with the possible exceptions of ploughing, are usually lighter. The capitalisation and the level of production of the horticultural holding is usually high; therefore the initial cost and subsequent high running costs of machinery can be more easily carried.

In the broad class of horticultural tractors there are machines rated at from 1 to 18 h.p., from one wheel to four wheel, and tracklayers. Generally those with four wheels or with tracks make more efficient use of their engine power owing to the fact that they have in contact with the ground a greater area of ' wheel ' surface, they therefore have a better grip and are likely to suffer less loss of power through wheel slip. The wheel equipment and its arrangement are probably the most important factors in the design of small tractors.

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Table 1 shows the draught requirements of some animal-drawn implements on a sandy loam in Trinidad, B.W.I. Table 2 shows the power being developed by the draught animals in similar work. The measurements for both tables were made by means of a spring-loaded drawbar dynamometer under normal conditions on level, tidy, well-farmed land. The soil was uniformly light and free from obstructions.

It will be seen in the tables that even on a light soil in all but the light cultivations, typical operations performed in farm practice by less than two ' animal ' h.p. are likely to require the maximum pull available from a typical 6 brake h.p. wheel tractor. Experience has so far shown that if such a tractor is put to work in the typically rough conditions of smallholder cultivations in Trinidad it cannot compete with a pair of good oxen as regards either rate of work or quality. The machine is liable to frequent engine stall or wheel slip, and the operator is under constant strain.

Two-wheel tractors

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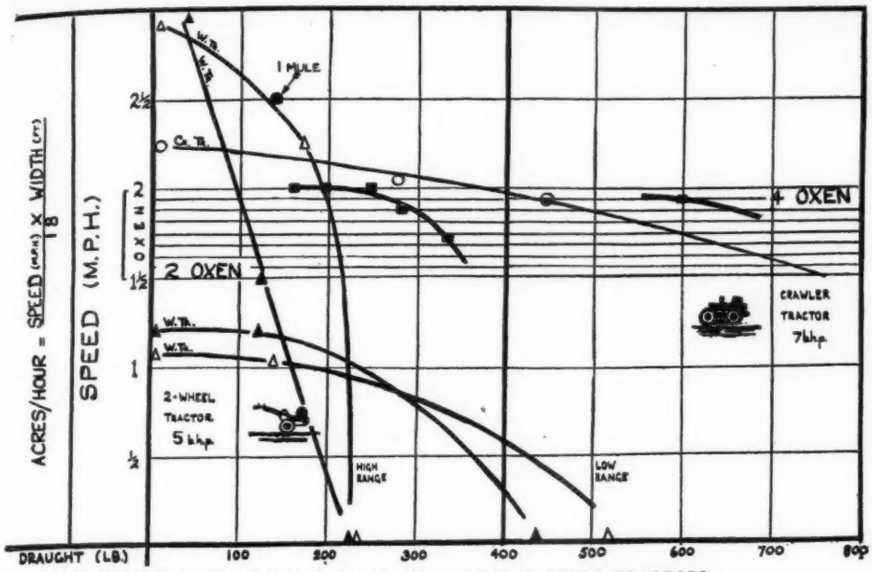

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h.p. two-wheel tractor would be capable of doing satisfactorily the lighter jobs normally undertaken by a mule, or up to two oxen, and rated at less than 2 effective h.p. In Table 1 the soil resistance figures show that the ploughing resistance of comparatively light, level, clean land increases by more than 100% as the soil becomes dry and hardens. Owing to the rapid changes in soil condition due mainly to rain and sun, ploughing may be possible for brief periods from time to time with a two-wheel horticultural tractor, but it is very unlikely that such a machine would enable a peasant to undertake cultivations at a time of year when he could not do them with a pair of oxen.

Small crawler tractors

A well-known crawler machine in roughly the same power class gives a maximum useful pull of 800 lb. This would enable it to perform all the operations listed in Tables 1 and 2. This surprising superiority in draught over its wheeled equivalent is mainly due to the efficiency of its tracks in traction. The diagram illustrates the performance of this machine as regards speed and draught in relation to the performance of oxen and a two-wheel tractor. The figures were obtained on a sandy loam in Trinidad.

The oxen were large zebus and they worked within the broad range of 1½-2 m.p.h. With two oxen at loads averaging about 300 lb. (maxima about 500 lb.) the animals were obviously labouring and slowing down. With four oxen loads as high as 900 lb. were hauled, but 500-600 lb. appeared to be comfortable. In the diagram a broad band of horizontal hatching indicates the likely working range of oxen, assuming that for loads below 400 lb. two would be used and at loads above 400 lb. four.

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With the crawler tractor the first measurement of speed and pull was made during the ploughing of land with a ploughing resistance of 5 lb./sq. in. to 6 in. deep by 9 in. wide, the second was taken on land of resistance 9 lb./sq. in., and the third was on the same land, but the load was a dead-weight. At no time was any track slip recorded. It will be seen that the performance of this machine closely resembles that of two to four oxen, and in Trinidad its initial cost is approximately the same as the cost of four good oxen. The question of the suitability of such a machine to the tropical farmer must therefore be decided by local conditions as affecting the cost of animals, the use, maintenance and operation of machines, and personal preferences in the general question of machine versus animal.

The special instance of the rotary cultivator should be mentioned here since this machine does not depend upon its tractive power to do its specialised job. Rotary cultivation with both large and small machines appears to be very successful in the tropics.

The indications are, then, that only the exceptional horticultural tractor can exert a sufficiently high mean drawbar pull satisfactorily to perform cultivations which could be done by a pair of oxen, and drawbar power is only a part of tractor performance. Price, convenience, accessibility, manoeuvrability, comfort and reputation are all important. On land traditionally farmed with animals the tractor, whether wheeled or tracked, may be hampered by inconvenient field shapes and sizes, open drains, bunds and poor roads. The smaller the tractor the more serious do the last three obstacles become. The initial cost of machinery is usually only a part of the cost of mechanisation. The enlargement of fields, provision of access, modification of drainage systems and gaining experience by trial require money and considerable forethought, both of which may be lacking on small farms. It is not unknown for mechanisation of field operations to enlarge the yield or area in crop so much as to cause embarrassment in handling, drying and processing at harvest time.

Medium-sized tractors

Mechanical efficiency under the generally rough conditions of the tropics can best be achieved by the use of large tractors. Undulations and obstructions in the ground are to some extent smoothed out by the longer wheel base, greater weight and additional strength. The initial cost of a medium-sized, popular four-wheel tractor of about 20 drawbar h.p. is little more than twice that of a 2½ drawbar h.p. 'horticultural' machine. It is more robust and, in the tropics, easier to drive. It has ample reserves of power to cope with all the work which small teams of oxen could undertake, and it can do it more quickly. Its maximum drawbar pull is over 3,000 lb.

Cultivation implements designed for use with powerful tractors are, in general, more suited to tropical conditions than the light tools provided for small tractors. Strong ploughs with digger, semi-digger or disc bottoms are favoured. Disc cultivators and ploughing harrows are useful, and the relatively high speed obtainable with medium tractors improves their performance. The medium-powered, wheeled tractor can be used for transportation, and

this is important where farmers produce crops for disposal in bulk to a factory or marketing organisation.

Co-operation

When the question of cost is raised the pointers are towards sharing machinery. The variants are several and well known. Machinery pools have not met with great success. Co-operative ownership of a contract service, private contracting and group farming appear to be more or less successful according to the type of agriculture and the temperament of the people concerned.

It is essential for even a small machinery co-operative to have a full-time, competent mechanic. He may also have to do the day-to-day management of the pool. Co-operatives sometimes provide only specialist services, but when they are formed as the very means of introducing mechanisation, they must aim first at removing or easing the factors limiting production. These may not be the initial cultivations as is so frequently assumed. On many tropical farms means of weed, pest and disease control would be of far greater use than means of cultivating and planting more land. On others the limit might be set by the quantity of crop that the farmer can harvest, dry and process by hand.

A strong co-operative or group farm can make better use of machinery than the individual smallholder. Machine operators are more easily trained, and they can become 'specialists.' Spare parts can be more readily bought and stored. Larger areas of land can be worked and community projects can be undertaken such as sanitary work, land drainage, the establishment of windbreaks and even the maintenance of a recreation field. The organisation of a machinery co-operative can conveniently coincide with the introduction of soil and water conservation into a district. Fuel can be saved by cultivating on the contour rather than up and down hill, and tractors can pull greater loads or wider implements.

Conclusion

Farmers tend to assume that they are good cultivators, that their traditional or habitual methods are the best or only methods. When they consider how to increase their production they probably look first for a means of increasing their physical ability to till the soil and handle more land. In a sense it is spectacular to have mechanical power to ease labour and to speed operations, but less spectacular means of agricultural improvement are likely to be much more effective on most peasant holdings. Advice on the use of fertilisers, the selection and care of seed, the proper management of livestock and the correct use of animal-drawn implements should come long before advice on tractors. In general the small 'market-garden' tractors are unsuitable for tropical peasant farming, and the benefits of mechanisation are likely to become available to small farmers only through co-operation in the use of larger machines.

In Trinidad, B.W.I., an East Indian market gardener cultivates a neighbour's land on contract, with a Howard rotary hoe

Transport is important where crops are disposed of in bulk, but small tractors are not suitable for the work. Sugar cane farmers in Trinidad

Kenaf—A New American Crop

A new American fibre crop has appeared—Kenaf (*Hibiscus cannabinus*)—which may become a valuable and effective substitute for jute (*Corchorus capsularis*).

It was first introduced privately to El Salvador; since then it has been cultivated in Cuba. The plant seems to be resistant to extreme heat and drought, and grows to an average height of 7½ ft. It was found that 58.4% of the plant consisted of stem, 38.5% being bark, in which occurs the fibre.

The fibre from kenaf is a soft stem fibre and can be utilised for the same purposes as jute. Tests with sugar bags made from jute compared with those made from kenaf showed kenaf to be superior.

Land in the Mallee district affected by erosion, caused through neglect and lack of scientific treatment

The World Problem of Erosion

Two Aspects of Conservation

Soil conservation has many aspects; in some countries it is a comparatively recent phenomenon, while in others it has existed literally for ages. To illustrate this, we reproduce below two articles; the first describes the position in the Mallee area in Victoria, Australia, where cultivation only commenced some 60 years ago. The second has been abstracted from the annual report of 1949 of the Soil Conservation Officer in Cyprus, Mr. L. J. Littlejohn, and discusses the position in that island where erosion has been a problem for thousands of years. Incidentally, the conditions in Cyprus approximate to those encountered throughout much of the Mediterranean region, while those in Victoria are more or less a replica of what has occurred in many wind swept continental areas in other parts of the world. Taken together they form an instructive study in contrasts.

I Soil Conservation in the Mallee

THE Mallee is a limestone plain extending over the north-west corner of the State of Victoria in south-east Australia. It gets its name from the hardy dwarf eucalypt which survives in this low-rainfall region where most other gums would perish. It was first opened to farming in 1890. Those who drew up plans for the original holdings had allowed for a belt of scrub to remain between each property, mainly to prevent erosion of the land, but settlers removed these belts and opened up the soil to the havoc of the winds.

Other factors hastened erosion. Instead of ploughing in their stubble, or sowing crops on it, many of the farmers burned it out, year after year. They believed that a good clean surface, free of straw, was essential to the next season's plantings. What this burning of the stubble really accomplished was the loosening and disintegration of the soil. The winds carried it away, piling it up against sheds and fences. Good topsoil covered roads and railway tracks. Winds blew it far across the State—it fell as a fine red dust in the streets of Melbourne, 300 miles away, and on ships out at sea.

In many districts of the Mallee there were hard outcrops of limestone, where not long before there had been rich red earth. Sand dunes crept into the wheat lands. Derelict houses told the tragic story.

Water for home use and for stock is supplied to a large part of the Mallee, as well as to the neighbouring region of the Wimmera, from reservoirs in the Grampian Mountains country further to the south. The State Rivers and Water Supply Commission has covered 11,000 square miles with a network of channels, which is one of the greatest watering systems of its kind in the world.

With the erosion of the Mallee soil, these channels silted up. It cost the State Government some £A72,000 a year to clean them out. In the 1945-46 season, following the drought of the previous summer, 12,000,000 cubic yards of silt had to be cleared from the channels at a

cost of £A385,000. That year over 500 farmers went without channel water.

Today there's a definite change coming over the face of the Mallee. This is partly due to the succession of good seasons that have covered the area with binding grasses. But the reason goes deeper than that. In the postwar period, Victoria, in common with the other Australian States, has begun to take energetic measures to combat wind and water erosion. Control methods suitable to Australian conditions are being used, and these are halting the drift of soils and reclaiming many lands that had been abandoned.

Co-operation

Several State authorities are co-operating with local farmers to stop further erosion in the Mallee. The State Rivers and Water Supply Commission, for instance, has resumed strips of land three chains wide on the windward side of the water channels, and has planted them with the hardy rye-corn. In this way, serious siltation has been avoided. A former Water Supply Commissioner, Mr. Harold Hanslow, helped to educate farmers in methods of erosion control. He gave impetus to this drive by starting competitions between farmers in five Mallee shires, to encourage them to use their initiative in checking the soil drift on their own properties. The competitions, since extended to other parts of the State where erosion problems are of a different kind, are proving most popular. Each year they are attracting increasing numbers of entrants.

The State's Soil Conservation Board has also been prominent in the fight against Mallee erosion. Despite its limited charter it has carried out much valuable research work as well as practical demonstrations among countrymen. Nowadays most farmers in the Mallee are conscious of the need to use their stubble as an earth binder instead of burning it. They are also planting their land with rye-corn, making increased use of superphosphates, and adopting a system of roughening up the soil to catch any drift by ploughing a series of strips at right angles to the direction of the wind. Today, too, the farmer can call on expert advice and see practical experiments in soil conservation at one of the 33 demonstration areas in the State.

Victoria's new Soil Conservation authority will have considerably wider powers than the Board it replaces. Much valuable experience has already been gained, and this will help to guide its activities. More important still, it will have the confidence and co-operation of the landholders themselves.

Contour furrows help to break down the wind velocity at ground level and slow down soil drift

Mallee country protected by rye and other ground cover

This ground cover of rye enables the land to resist wind erosion during a dry spell

II Soil Conservation in Cyprus

FOR many centuries the Cyprus farmer has employed dry stone or simple masonry walls for terracing, water spreading and generally minimising the effects of erosion. Under conditions of subsistence peasant farming such structures, which are most expensive in terms of human labour, could be erected not only because hired labour was far cheaper than it is today, but also because the farmer could write off the cost of his own and his family's labour. As the Cyprus farmer operates more and more on a cash and not on a subsistence economy the construction of such works becomes more and more difficult for the individual farmer to undertake. It is the aim of the Soil Conservation Service to devise and demonstrate methods of conservation farming which can be economically adopted under modern conditions by the Cyprus farmers either individually or collectively.

Villagers working on a local terracing scheme in Epiphanos, Cyprus

Measures on steep land

On steep land in the hills, normally devoted to vines or almonds and where, up till now, the only conservation measures undertaken were the construction of dry stone walls, often on a most inadequate scale, it would appear, from the technical point of view, that the construction of 'gradoni' (contour steps 3-5 ft. wide and with an inward slope from the lip towards the hill) is a practical method of conservation. Vines can either be planted on the gradoni or on the slopes between, and almonds or other tree crops grown on the gradoni. As a means of demonstrating the system schemes were undertaken in a number of villages whereby the owners of land worked on their own properties preparing the ground by the construction of gradoni and were paid by the Soil Conservation Service at half the rate in force for ordinary casual labour ; *i.e.* the total cost of the work was shared equally between the property owner and Government.

The intention in undertaking this type of scheme was that, as the system became known and, it was hoped, appreciated, the proportion of direct assistance given would be reduced until the Soil Conservation Service was providing only technical assistance. It was noticeable, however, that even on a 50:50 basis such schemes were only taken up by the poorer villages in the Tylleria and Pitsilia areas, and it soon became apparent that the main attraction of the scheme to the villagers was not the development of their properties but the opportunity of earning hard cash, and in many cases after the work was completed the subsequent planting and cultivating were neglected. Efforts to get the schemes to continue with a smaller Government contribution have not so far met with much success—a few people are prepared to work on a 2:1 basis—and it is evident that the basic reason for the neglect of land in many of the poorer areas in Cyprus is that the owners cannot afford the capital necessary for its development. They certainly cannot supply capital in the form of money, and their labour, which they might appear able to afford, has got to be used in work which will bring in quick returns either in food or cash. They cannot afford to invest much of their labour in long term development works such as soil conservation and planting of vines or trees which are not going to bring in any return for several years. If this analysis is correct the policy of giving direct subsidies for specific conservation works of the type described above will require consideration as it is obvious that direct financial assistance on the scale necessary to make any material difference to the amount of erosion going in the hill areas of Cyprus is out of the question.

Measures on plain areas

In the plain areas, on arable land which is not subject to flood irrigation, the standard technique so far adopted is the erection of earth banks on the true contour, spaced at such intervals as will, it is hoped, enable them to hold all the anticipated run off. Such earth banks can be quickly and cheaply erected with modern equipment, and schemes involving them have been carried out in a number of villages.

The main physical difficulty in carrying out this type of work is, of course, the fact that it is only possible if a natural unit of land is treated as one piece and existing boundaries within the area are ignored to a great extent. Under Cyprus conditions, where properties are dispersed as separate plots which seldom bear any relation to the natural features of the ground and where the number of persons with an interest in any given area is often large, it is difficult to bring about the degree of co-operation which is necessary to enable schemes of this type to be carried out. Most of the schemes so far executed have been in fairly large properties or on Government land, but a few of the smaller schemes have covered areas in which a number of different persons were interested.

In some areas where the existing plot boundaries run more or less on the contour and at right angles to the contour it is possible to bund each plot in such a way as to hold all the anticipated run off. Such a scheme covering over 300 donums has been carried out at Ypsonas (1 donum = $\frac{1}{4}$ acre).

Difficulties

It has been found that there are one or two difficulties associated with the general practice of trying to hold all run-off on the field in which it falls. The first is a psychological one associated with the Cyprus farmers' desire to divert, if at all possible, any run-off from other areas on to his arable land. It has been found that in many cases where contour earth banks have been erected in a field in such a way

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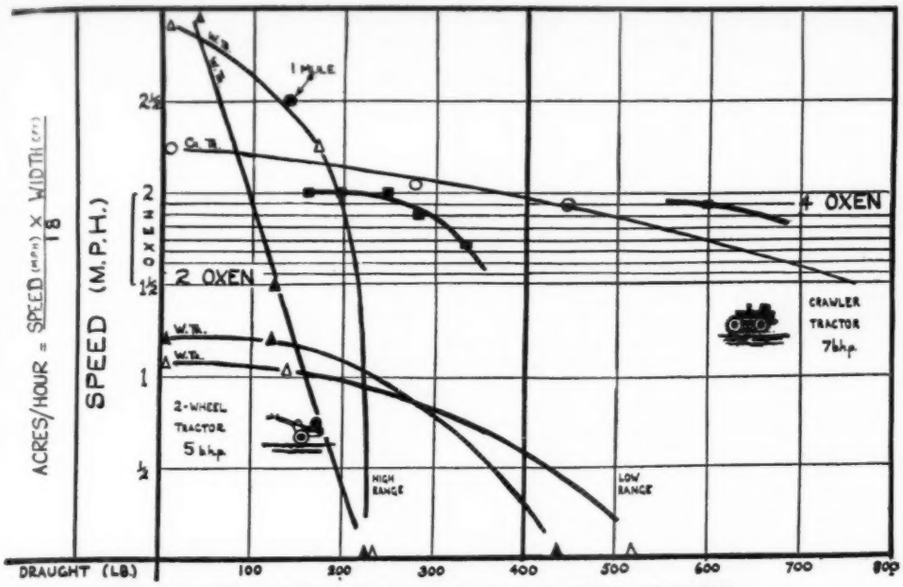

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Comparison of the two

The wheeled tractor was a compact American-built unit of sound design and construction powered by a 5 h.p. engine and provided with two-speed gears. Alternative pneumatic- and steel-wheel equipments were available. The steel wheels had strakes and incorporated a reduction gear. Since the tools for use with this tractor were designed for direct attachment it was not possible to measure draught in actual work. An 'artificial' load was applied through the drawbar dynamometer on short grass over a sandy loam. No engine stall was recorded, but in each gear, with increasing load, wheel slip ultimately became 100%.

With the crawler tractor the first measurement of speed and pull was made during the ploughing of land with a ploughing resistance of 5 lb./sq. in. to 6 in. deep by 9 in. wide, the second was taken on land of resistance 9 lb./sq. in., and the third was on the same land, but the load was a dead-weight. At no time was any track slip recorded. It will be seen that the performance of this machine closely resembles that of two to four oxen, and in Trinidad its initial cost is approximately the same as the cost of four good oxen. The question of the suitability of such a machine to the tropical farmer must therefore be decided by local conditions as affecting the cost of animals, the use, maintenance and operation of machines, and personal preferences in the general question of machine versus animal.

The special instance of the rotary cultivator should be mentioned here since this machine does not depend upon its tractive power to do its specialised job. Rotary cultivation with both large and small machines appears to be very successful in the tropics.

The indications are, then, that only the exceptional horticultural tractor can exert a sufficiently high mean drawbar pull satisfactorily to perform cultivations which could be done by a pair of oxen, and drawbar power is only a part of tractor performance. Price, convenience, accessibility, manoeuvrability, comfort and reputation are all important. On land traditionally farmed with animals the tractor, whether wheeled or tracked, may be hampered by inconvenient field shapes and sizes, open drains, bunds and poor roads. The smaller the tractor the more serious do the last three obstacles become. The initial cost of machinery is usually only a part of the cost of mechanisation. The enlargement of fields, provision of access, modification of drainage systems and gaining experience by trial require money and considerable forethought, both of which may be lacking on small farms. It is not unknown for mechanisation of field operations to enlarge the yield or area in crop so much as to cause embarrassment in handling, drying and processing at harvest time.

Medium-sized tractors

Mechanical efficiency under the generally rough conditions of the tropics can best be achieved by the use of large tractors. Undulations and obstructions in the ground are to some extent smoothed out by the longer wheel base, greater weight and additional strength. The initial cost of a medium-sized, popular four-wheel tractor of about 20 drawbar h.p. is little more than twice that of a 2½ drawbar h.p. 'horticultural' machine. It is more robust and, in the tropics, easier to drive. It has ample reserves of power to cope with all the work which small teams of oxen could undertake, and it can do it more quickly. Its maximum drawbar pull is over 3,000 lb.

Cultivation implements designed for use with powerful tractors are, in general, more suited to tropical conditions than the light tools provided for small tractors. Strong ploughs with digger, semi-digger or disc bottoms are favoured. Disc cultivators and ploughing harrows are useful, and the relatively high speed obtainable with medium tractors improves their performance. The medium-powered, wheeled tractor can be used for transportation, and

this is important where farmers produce crops for disposal in bulk to a factory or marketing organisation.

Co-operation

When the question of cost is raised the pointers are towards sharing machinery. The variants are several and well known. Machinery pools have not met with great success. Co-operative ownership of a contract service, private contracting and group farming appear to be more or less successful according to the type of agriculture and the temperament of the people concerned.

It is essential for even a small machinery co-operative to have a full-time, competent mechanic. He may also have to do the day-to-day management of the pool. Co-operatives sometimes provide only specialist services, but when they are formed as the very means of introducing mechanisation, they must aim first at removing or easing the factors limiting production. These may not be the initial cultivations as is so frequently assumed. On many tropical farms means of weed, pest and disease control would be of far greater use than means of cultivating and planting more land. On others the limit might be set by the quantity of crop that the farmer can harvest, dry and process by hand.

A strong co-operative or group farm can make better use of machinery than the individual smallholder. Machine operators are more easily trained, and they can become 'specialists.' Spare parts can be more readily bought and stored. Larger areas of land can be worked and community projects can be undertaken such as sanitary work, land drainage, the establishment of windbreaks and even the maintenance of a recreation field. The organisation of a machinery co-operative can conveniently coincide with the introduction of soil and water conservation into a district. Fuel can be saved by cultivating on the contour rather than up and down hill, and tractors can pull greater loads or wider implements.

Conclusion

Farmers tend to assume that they are good cultivators, that their traditional or habitual methods are the best or only methods. When they consider how to increase their production they probably look first for a means of increasing their physical ability to till the soil and handle more land. In a sense it is spectacular to have mechanical power to ease labour and to speed operations, but less spectacular means of agricultural improvement are likely to be much more effective on most peasant holdings. Advice on the use of fertilisers, the selection and care of seed, the proper management of livestock and the correct use of animal-drawn implements should come long before advice on tractors. In general the small 'market-garden' tractors are unsuitable for tropical peasant farming, and the benefits of mechanisation are likely to become available to small farmers only through co-operation in the use of larger machines.

In Trinidad, B.W.I., an East Indian market gardener cultivates a neighbour's land on contract, with a Howard rotary hoe

Transport is important where crops are disposed of in bulk, but small tractors are not suitable for the work. Sugar cane farmers in Trinidad

Kenaf—A New American Crop

A new American fibre crop has appeared—Kenaf (*Hibiscus cannabinus*)—which may become a valuable and effective substitute for jute (*Corchorus capsularis*).

It was first introduced privately to El Salvador; since then it has been cultivated in Cuba. The plant seems to be resistant to extreme heat and drought, and grows to an average height of 7½ ft. It was found that 58.4% of the plant consisted of stem, 38.5% being bark, in which occurs the fibre.

The fibre from kenaf is a soft stem fibre and can be utilised for the same purposes as jute. Tests with sugar bags made from jute compared with those made from kenaf showed kenaf to be superior.

Land in the Mallee district affected by erosion, caused through neglect and lack of scientific treatment

The World Problem of Erosion

Two Aspects of Conservation

Soil conservation has many aspects; in some countries it is a comparatively recent phenomenon, while in others it has existed literally for ages. To illustrate this, we reproduce below two articles; the first describes the position in the Mallee area in Victoria, Australia, where cultivation only commenced some 60 years ago. The second has been abstracted from the annual report of 1949 of the Soil Conservation Officer in Cyprus, Mr. L. J. Littlejohn, and discusses the position in that island where erosion has been a problem for thousands of years. Incidentally, the conditions in Cyprus approximate to those encountered throughout much of the Mediterranean region, while those in Victoria are more or less a replica of what has occurred in many wind swept continental areas in other parts of the world. Taken together they form an instructive study in contrasts.

I Soil Conservation in the Mallee

THE Mallee is a limestone plain extending over the north-west corner of the State of Victoria in south-east Australia. It gets its name from the hardy dwarf eucalypt which survives in this low-rainfall region where most other gums would perish. It was first opened to farming in 1890. Those who drew up plans for the original holdings had allowed for a belt of scrub to remain between each property, mainly to prevent erosion of the land, but settlers removed these belts and opened up the soil to the havoc of the winds.

Other factors hastened erosion. Instead of ploughing in their stubble, or sowing crops on it, many of the farmers burned it out, year after year. They believed that a good clean surface, free of straw, was essential to the next season's plantings. What this burning of the stubble really accomplished was the loosening and disintegration of the soil. The winds carried it away, piling it up against sheds and fences. Good topsoil covered roads and railway tracks. Winds blew it far across the State—it fell as a fine red dust in the streets of Melbourne, 300 miles away, and on ships out at sea.

In many districts of the Mallee there were hard outcrops of limestone, where not long before there had been rich red earth. Sand dunes crept into the wheat lands. Derelict houses told the tragic story.

Water for home use and for stock is supplied to a large part of the Mallee, as well as to the neighbouring region of the Wimmera, from reservoirs in the Grampian Mountains country further to the south. The State Rivers and Water Supply Commission has covered 11,000 square miles with a network of channels, which is one of the greatest watering systems of its kind in the world.

With the erosion of the Mallee soil, these channels silted up. It cost the State Government some £A72,000 a year to clean them out. In the 1945-46 season, following the drought of the previous summer, 12,000,000 cubic yards of silt had to be cleared from the channels at a

cost of £A385,000. That year over 500 farmers went without channel water.

Today there's a definite change coming over the face of the Mallee. This is partly due to the succession of good seasons that have covered the area with binding grasses. But the reason goes deeper than that. In the postwar period, Victoria, in common with the other Australian States, has begun to take energetic measures to combat wind and water erosion. Control methods suitable to Australian conditions are being used, and these are halting the drift of soils and reclaiming many lands that had been abandoned.

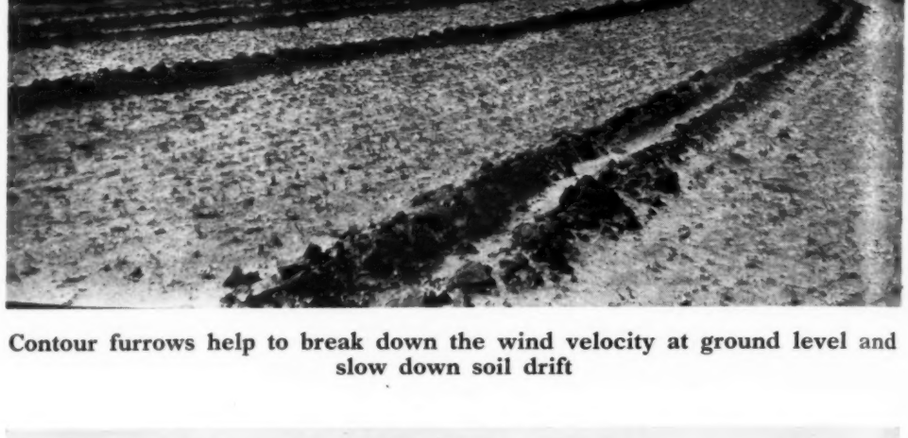
Co-operation

Several State authorities are co-operating with local farmers to stop further erosion in the Mallee. The State Rivers and Water Supply Commission, for instance, has resumed strips of land three chains wide on the windward side of the water channels, and has planted them with the hardy rye-corn. In this way, serious siltation has been avoided. A former Water Supply Commissioner, Mr. Harold Hanslow, helped to educate farmers in methods of erosion control. He gave impetus to this drive by starting competitions between farmers in five Mallee shires, to encourage them to use their initiative in checking the soil drift on their own properties. The competitions, since extended to other parts of the State where erosion problems are of a different kind, are proving most popular. Each year they are attracting increasing numbers of entrants.

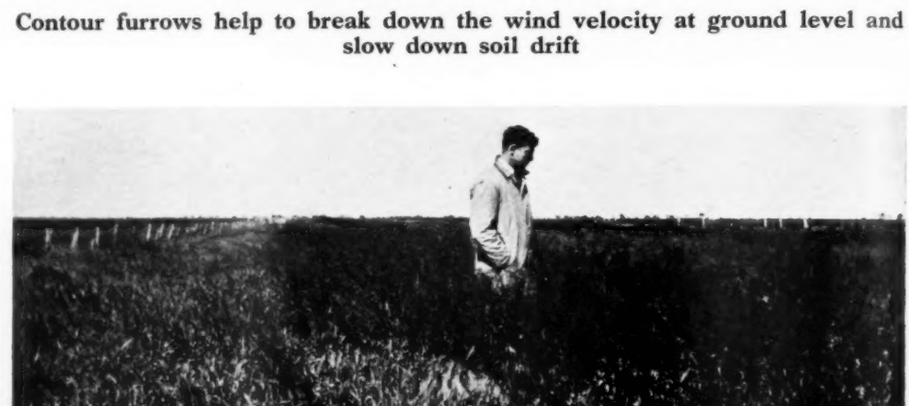
The State's Soil Conservation Board has also been prominent in the fight against Mallee erosion. Despite its limited charter it has carried out much valuable research work as well as practical demonstrations among countrymen. Nowadays most farmers in the Mallee are conscious of the need to use their stubble as an earth binder instead of burning it. They are also planting their land with rye-corn, making increased use of superphosphates, and adopting a system of roughening up the soil to catch any drift by ploughing a series of strips at right angles to the direction of the wind. Today, too, the farmer can call on expert advice and see practical experiments in soil conservation at one of the 33 demonstration areas in the State.

Victoria's new Soil Conservation authority will have considerably wider powers than the Board it replaces. Much valuable experience has already been gained, and this will help to guide its activities. More important still, it will have the confidence and co-operation of the landholders themselves.

Contour furrows help to break down the wind velocity at ground level and slow down soil drift



Mallee country protected by rye and other ground cover



This ground cover of rye enables the land to resist wind erosion during a dry spell

II Soil Conservation in Cyprus

FOR many centuries the Cyprus farmer has employed dry stone or simple masonry walls for terracing, water spreading and generally minimising the effects of erosion. Under conditions of subsistence peasant farming such structures, which are most expensive in terms of human labour, could be erected not only because hired labour was far cheaper than it is today, but also because the farmer could write off the cost of his own and his family's labour. As the Cyprus farmer operates more and more on a cash and not on a subsistence economy the construction of such works becomes more and more difficult for the individual farmer to undertake. It is the aim of the Soil Conservation Service to devise and demonstrate methods of conservation farming which can be economically adopted under modern conditions by the Cyprus farmers either individually or collectively.

Villagers working on a local terracing scheme in Epiphanos, Cyprus

Measures on steep land

On steep land in the hills, normally devoted to vines or almonds and where, up till now, the only conservation measures undertaken were the construction of dry stone walls, often on a most inadequate scale, it would appear, from the technical point of view, that the construction of 'gradoni' (contour steps 3-5 ft. wide and with an inward slope from the lip towards the hill) is a practical method of conservation. Vines can either be planted on the gradoni or on the slopes between, and almonds or other tree crops grown on the gradoni. As a means of demonstrating the system schemes were undertaken in a number of villages whereby the owners of land worked on their own properties preparing the ground by the construction of gradoni and were paid by the Soil Conservation Service at half the rate in force for ordinary casual labour ; *i.e.* the total cost of the work was shared equally between the property owner and Government.

The intention in undertaking this type of scheme was that, as the system became known and, it was hoped, appreciated, the proportion of direct assistance given would be reduced until the Soil Conservation Service was providing only technical assistance. It was noticeable, however, that even on a 50:50 basis such schemes were only taken up by the poorer villages in the Tylleria and Pitsilia areas, and it soon became apparent that the main attraction of the scheme to the villagers was not the development of their properties but the opportunity of earning hard cash, and in many cases after the work was completed the subsequent planting and cultivating were neglected. Efforts to get the schemes to continue with a smaller Government contribution have not so far met with much success—a few people are prepared to work on a 2:1 basis—and it is evident that the basic reason for the neglect of land in many of the poorer areas in Cyprus is that the owners cannot afford the capital necessary for its development. They certainly cannot supply capital in the form of money, and their labour, which they might appear able to afford, has got to be used in work which will bring in quick returns either in food or cash. They cannot afford to invest much of their labour in long term development works such as soil conservation and planting of vines or trees which are not going to bring in any return for several years. If this analysis is correct the policy of giving direct subsidies for specific conservation works of the type described above will require consideration as it is obvious that direct financial assistance on the scale necessary to make any material difference to the amount of erosion going in the hill areas of Cyprus is out of the question.

Measures on plain areas

In the plain areas, on arable land which is not subject to flood irrigation, the standard technique so far adopted is the erection of earth banks on the true contour, spaced at such intervals as will, it is hoped, enable them to hold all the anticipated run off. Such earth banks can be quickly and cheaply erected with modern equipment, and schemes involving them have been carried out in a number of villages.

The main physical difficulty in carrying out this type of work is, of course, the fact that it is only possible if a natural unit of land is treated as one piece and existing boundaries within the area are ignored to a great extent. Under Cyprus conditions, where properties are dispersed as separate plots which seldom bear any relation to the natural features of the ground and where the number of persons with an interest in any given area is often large, it is difficult to bring about the degree of co-operation which is necessary to enable schemes of this type to be carried out. Most of the schemes so far executed have been in fairly large properties or on Government land, but a few of the smaller schemes have covered areas in which a number of different persons were interested.

In some areas where the existing plot boundaries run more or less on the contour and at right angles to the contour it is possible to bund each plot in such a way as to hold all the anticipated run off. Such a scheme covering over 300 donums has been carried out at Ypsonas (1 donum = $\frac{1}{3}$ acre).

Difficulties

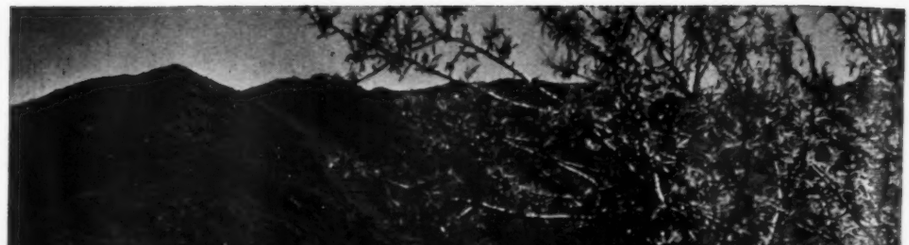
It has been found that there are one or two difficulties associated with the general practice of trying to hold all run-off on the field in which it falls. The first is a psychological one associated with the Cyprus farmers' desire to divert, if at all possible, any run-off from other areas on to his arable land. It has been found that in many cases where contour earth banks have been erected in a field in such a way

as to hold all the normal run-off expected, the works have been subjected to strains for which they were not designed by the farmer diverting run-off from roadside channels or other sources into the banks, which ultimately overflow and break. This can only be overcome by educating the farmer, but it is disappointing repeatedly to find that well designed works are breaking down through deliberate action on the part of the farmers.

The second difficulty is more serious in that it is now apparent that it is not possible to hold all the run-off from all types of land, and in particular it is not possible on soils derived from the Kythrean formation. These soils are fine clays with a very slow absorptive capacity and the underlying rock, which is often close to the surface, is very impervious. . Under such conditions contour earth banks, unless set so close together as to prevent arable cultivation in between, will not hold all the run-off. Moreover, the soils fissure to such an extent during summer that the first rains find many cracks through and below the banks, which may break because this 'underground' erosion undermines them. Graded channels designed to dispose of the run-off in protected waterways are, of course, the theoretical answer but are difficult to plan in Cyprus because most minor waterways are, if at all possible, cultivated right across.

Irrigated land

On land which is subject to flood irrigation, considerable damage is done annually because of the large volumes of water which are diverted wherever possible onto arable land and which sweep about under very little control. Land subject to flood irrigation is, however, so much more valuable than unirrigated arable land that it is worth spending considerably more in protecting it. This problem is being tackled from different aspects. Where the volume of water concerned is of reasonable dimensions or is subject to some degree of control, it is possible to bund each field and cascade the water from one field to another over suitable spillways. If there is not too much slope it is even possible to level each field between the bunds. The first work of this type was constructed last year and aroused very great interest on the part of the farmers, since the benefits were immediately apparent, and applications for levelling and bunding have been far greater than the Service could cope with. The weakest point in such systems is the provision of adequate spillways, and as these are the most costly item the inevitable tendency on the part of farmers is to skimp them, either by not making them wide enough to carry the anticipated volume of water, which results in the enclosing earth bund being breached, or by not constructing an adequate apron, which results in the spillway being undercut and collapsing. Efforts are being made to design a cheap and sound spillway for such works.



A country irrigation tank in Cyprus, holding 20,000 gal.; it is fed by a weir

Reservoirs

The other angle from which the problem of controlling flood irrigation is being tackled is by the construction of detention reservoirs, so that the flash floods which follow every storm may be delayed and released gradually, so enabling the water to be used under proper control. With modern earth-moving equipment earth dams can be constructed cheaply, and the first structure of this type was erected in co-operation with the Water Supply and Irrigation Department at Kanli Keuy. It consisted of an earth dam 20 ft. high at its highest point and containing 9,000 cu. yd. of compacted earth. The estimated capacity of the reservoir so formed was 40 million gal., the catchment area being about 9 square miles. The total cost, including all charges other than technical supervision, amounted to £1,320.

Policy

The general policy followed in carrying out soil conservation works on private land has been to demonstrate a technique, if necessary free of charge at first, and then gradually to increase the charges made for carrying out similar work until the beneficiaries are paying at least the bare operating costs for the work. This policy has proved very successful in the case of levelling and bunding referred to above since the technique is so beneficial that farmers, in areas where successful demonstrations have been carried out, are now prepared to pay even contractors' charges to get the work done, and at least one private firm has, during the past year, carried out a considerable amount of levelling on agricultural land. This, while very gratifying, is not an unmixed blessing, as in some cases levelling has been undertaken on sites where it is impossible to control the volume of water which may come down and the work may be lost in one winter's storm, with consequent discouragement to the farmer.

While the execution of specific works represents the most immediate work of the Soil Conservation Service, in the long term view it is undoubtedly equally, if not more, important that the conditions for general agricultural development on sound conservation lines should be studied and, where possible, altered to permit of progressive farmers or villages adapting their farming systems to better methods of land use. Apart from financial considerations, the two most important factors which militate against better land use are the general system of land tenure and the methods of animal husbandry. The effects of these two factors have been too often described to require repetition here. Apart from revolutionary changes in the existing systems of tenure of land, one possible way in which a progressive village or group of farmers might be enabled to make better use of their land would be by enabling

them to form a local administrative body which would have a certain amount of control over the methods of farming adopted in a defined area. A draft Soil Conservation Law which would enable 'soil conservation areas' to be set up in much the same way as irrigation divisions are set up at the present moment has been prepared and is being studied by the Government.

Land tenure

At the same time a number of experiments in different systems of land tenure are being or will be tried out, either on Crown Land or on private land by co-operative societies. Until recently it has been widely held in Cyprus that only by giving, or at least holding out the promise of outright ownership, is it possible to interest Cyprus farmers in good agricultural development. 'The magic of ownership turns sand to gold' is a tenet which has been blindly accepted in spite of the fact that, over large areas in Cyprus, peasant ownership has, and is, rapidly turning 'golden' land to bare rock. In accordance with this theory several areas of Crown Land have been alienated on conditional lease-purchase agreements, the conditions usually being that adequate soil conservation measures should be taken before the land is finally alienated. In general, these agreements have failed entirely in their purpose—the conditions have not been fulfilled and it has proved impossible to dispossess the occupiers once the land has been allocated to them. Various methods of inducing the lessees to construct adequate soil conservation works are being tried, but, generally speaking, it has been shown that unless a system can be very clearly demonstrated to be within the farmers' capability and likely to bring him increased returns fairly quickly neither threats nor promises are likely to be effective.

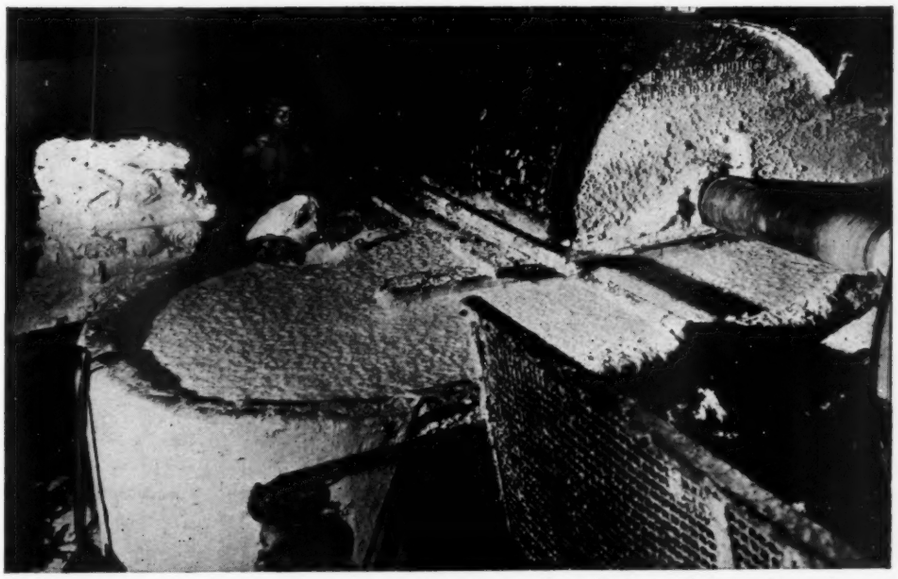
Expanding South African Pulp and Paper Industry

South Africa's paper and pulp factory is situated on the surface of a prosperous gold mine, 30 miles from Johannesburg. The factory uses 85,000,000 gal. a month of water pumped up from thousands of feet below the surface, and produces 1,350 tons of fine white paper and 200 tons of cardboard every month from South African materials.

The development of this pulp and paper industry starts in the pine-gum and wattle forests and in the salt pans of the country. Timber, water and salt, all in enormous quantities, are required to feed the process of paper-making, which depends for perfection on continuous supervision and control of all stages of the process. From the wattle, pine and gum forests timber is delivered to the storage yards of the factory to enable a steady monthly consumption of 3,000 tons to be maintained.

Experiments with combinations of the timbers available are continually being undertaken, and different types of paper are emerging. Routine tests are performed throughout the 24 hours of the day in all manufacturing sections of the factory, including tests on production every two hours.

The interests which control South Africa's paper mills have carried out an extensive survey of the raw materials available in the Union with a view to expanding output. The factory is meeting a steadily increasing demand for its products, and it is visualised that an extension will soon be warranted; with this in mind a site has been acquired near the mouth of the Tugela River in Natal, where a new factory will supplement production.



The beating process; pulp is passed between parallel steel bars in a large, revolving steel drum, over a bed of similar bars located in the bed of the beater, causing the fibres to knit together and form an even sheet

Stripped logs being fed into a V-shaped conveyor which carries the timber to rotary chippers

Pest Killers must not be Man Killers

W. E. RIPPER, Ph.D., F.R.E.S.

Managing Director of Pest Control Ltd.

We have previously drawn attention in this journal to the risks attendant on the work of spraying toxic insecticides, such as DNOC and parathion, when carried out by operators without adequate knowledge of the dangers involved. The following article is timely, since the British Ministry of Agriculture has recently set up a Working Party to examine the whole question, the report of which will, it is anticipated, shortly be published.

THE great increase in the use of toxic insecticides and herbicides has caused a number of casualties, some of which have proved fatal. While the accident rate of the agricultural worker does not compare unfavourably with that of the industrial worker, the increase in the number of fatal casualties among agricultural workers has given rise to alarm. Warnings have been voiced, some of which have been accompanied by constructive suggestions on measures which could be taken to prevent casualties and, in this country, Dr. Donald Hunter, Dr. P. L. Bidstrup and the writer have attempted, by giving demonstrations and lectures, to explain suitable methods of preventative medicine. Nevertheless, in many cases these were ignored and further fatal accidents occurred.

Toxic categories

A number of spray chemicals are not more toxic than the disinfectants in general use but, unfortunately, they are not effective in solving *all* pest and weed problems. Certain very important spray chemicals are extremely toxic, but their effectiveness in dealing with otherwise insoluble problems is so great as to render them indispensable. The toxic risks attendant upon the use of these latter spray chemicals for the control of pests and weeds fall into two categories—namely (1) acute poisoning of the operatives on the spraying machines and, with some insecticides, other agricultural workers present on the site of spraying during or immediately after treatment; and (2) chronic poisoning of operatives, or of consumers of treated foodstuffs.

The first requirement in the safe use of a toxic material is an adequate knowledge of the mammalian toxicity of the compound. It must be admitted that, in the past, applied entomologists and economic botanists have not always paid sufficient attention to mammalian toxicity of sub-lethal quantities and the danger of ensuing chronic poisoning by the spray chemicals which they recommended. In the last three years the leading spray chemical manufacturers in the United States and this country have intensified the study of the toxicology of their products and the development of protective measures and antidotes to the poisons. In a number of organisations, the sale of a chemical is not allowed until adequate information on its toxicity is available. It is hoped that this practice will be generally accepted and in the future manufacturers will not bring a new insecticide or a new weedkiller on to the market until a comprehensive enquiry into the toxicology of the new chemical, as set out by Lehman, has been completed.

Practical protection

Provided the knowledge of toxic dosages, mode of entry into the body and pathological effects is adequate, it is possible to recommend measures to prevent *acute poisoning* of spray operatives, but it is important that the measures recommended are such that workmen can comfortably comply with them. We deprecate the recommendation of unpleasant or irksome practices, such as the wearing of gas-masks and gasproof clothing on hot summer days, and the subsequent placing of responsibility for casualties upon the carelessness of the workmen who discarded the protective clothing when temperature made the wearing of it unbearable.

With many of the toxic spray chemicals, weekly medical supervision and examination is necessary. In the case of certain important compounds, methods are now available for pre-diagnosis of early pathological symptoms, by diagnosing the uptake of the toxicant before any discomfort is felt by the patient.

Eight-point safety code

In addition, workpeople engaged in spraying must be made safety conscious, and this is only possible with a fairly high standard of intelligence and skill on the part of the spray operative. The old contention that any farmhand can be employed on spraying operations is dangerous and incorrect, if the operatives' safety is to be considered. To begin with, a spray operator must be a well-trained and skilled workman. His protection is then effected by the provision of our eight-point safety code comprising the following:

(1) A complete prevention of contamination by placing the operative in a gas-proof, air-conditioned cab fitted on the tractor, which precludes any possibility of skin contact with spray drift and inhalation of toxic fumes, and also ensures pleasant working conditions.

(2) The minimising of the necessity for handling spray chemicals. A number of accidents can be traced to splashing when tins are opened, or to the too-casual disposal of contaminated empty containers. To avoid this danger, we have, in our organisation, reduced the use of tins to a minimum by the introduction of bulk handling methods, a practice which lends itself to a much greater cleanliness of operations. Where the pouring of chemicals cannot be avoided, anti-splash tins are used.

In the bulk handling system installations, the spray liquid is pumped from the manufacturing plant in the factory to big storage

WRONG ↓

Courting disaster: (1) no protection to neck and face; (2) no protection of eyes; (3) cigarette handled with contaminated hands; (4) no overalls; (5) no gloves, bare arms and hands splashed with spray; (6) drum gives splash when pouring and is itself contaminated; (7) spray liquid splashed about on tank; (8) leather sandals absorb the spray and allow contact with skin

RIGHT ↑

Safe: (1) hood protects head and neck; (2) visor protects eyes and face; (3) no smoking; (4) white overalls protect clothing and skin; (5) rubber gloves; (6) special non-splash can; (7) no spray liquid splashed on tanks; (8) rubber boots, no spray absorption

tanks, whence it is taken to the distributive centres in large bridging tankers. At the distributive centres, the chemicals are transferred to depot storage tanks, from which small bulk handling automotive units draw supplies and deliver to the spraying machines.

(3) The use of protective clothing. Workpeople are issued with garments of a colour on which splashes become immediately conspicuous; where necessary they are fitted with hoods. These garments are laundered regularly every three days, by a method which prevents contamination with other washings. A neat clean garment encourages a conscientious workman to handle chemicals carefully and to work cautiously so as to avoid splashing and, moreover, enables him to wash off any accidental splashes which may occur, and which become immediately visible.

Natural rubber gloves and rubber boots, fitted with internal steel caps to protect the toes, are also provided.

For many operations visors are worn to prevent splashing of the eyes and face; these visors are more comfortable than goggles and can be easily flapped back when their use is not required.

(4) The issue of prophylactic drugs and supplementation of the diet to increase resistance.

(5) The enforcement, as a condition of employment, of a regular medical examination, so that dangerous quantities of toxic substance in the blood can be diagnosed long before pathological symptoms occur.

(6) The provision of first-aid kits which, in addition to the usual first-aid equipment and drugs, contain antidotes for use in emergencies, also instructions for treatment of casualties for the information of the doctor if it should happen that a casualty is treated by a doctor outside the company's medical organisation.

(7) Training of the operatives in ' safety consciousness ' by suitable lectures and the institution of a Safety Council in the organisation, before which supervisors in charge of the workpeople must vindicate themselves in the event of an accident. No preventative medicine will be effective unless the operatives are thoroughly safety conscious. We impress upon our operatives the necessity for distinguishing themselves from other agricultural workers by their thorough knowledge of the safe handling of poisons. They are taught that to handle toxicants without endangering their own lives or the lives of others, is an integral part of their craftsmanship.

(8) Constant technical supervision of all spray operations by fully qualified personnel.

An analysis of the accidents which have occurred has shown that sets of circumstances frequently arise which can lead indirectly to a toxic hazard unless a fully qualified person is present to supervise operations, who can recognise the danger even in involved issues and so direct operations accordingly.

By introducing this eight-point safety code, we have been able to spray hundreds of thousands of acres with dinitro compounds, and tens of thousands with parathion and similar organic phosphorus compounds without a single accident. On the other hand, an intensive study of the casualties which have occurred in this country, U.S.A. and France, has proved that the observance of each one of these eight points is indispensable if safety is to be guaranteed.

Non-professional users

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Pest Killers must not be Man Killers

W. E. RIPPER, Ph.D., F.R.E.S.

Managing Director of Pest Control Ltd.

We have previously drawn attention in this journal to the risks attendant on the work of spraying toxic insecticides, such as DNOC and parathion, when carried out by operators without adequate knowledge of the dangers involved. The following article is timely, since the British Ministry of Agriculture has recently set up a Working Party to examine the whole question, the report of which will, it is anticipated, shortly be published.

THE great increase in the use of toxic insecticides and herbicides has caused a number of casualties, some of which have proved fatal. While the accident rate of the agricultural worker does not compare unfavourably with that of the industrial worker, the increase in the number of fatal casualties among agricultural workers has given rise to alarm. Warnings have been voiced, some of which have been accompanied by constructive suggestions on measures which could be taken to prevent casualties and, in this country, Dr. Donald Hunter, Dr. P. L. Bidstrup and the writer have attempted, by giving demonstrations and lectures, to explain suitable methods of preventative medicine. Nevertheless, in many cases these were ignored and further fatal accidents occurred.

Toxic categories

A number of spray chemicals are not more toxic than the disinfectants in general use but, unfortunately, they are not effective in solving *all* pest and weed problems. Certain very important spray chemicals are extremely toxic, but their effectiveness in dealing with otherwise insoluble problems is so great as to render them indispensable. The toxic risks attendant upon the use of these latter spray chemicals for the control of pests and weeds fall into two categories—namely (1) acute poisoning of the operatives on the spraying machines and, with some insecticides, other agricultural workers present on the site of spraying during or immediately after treatment; and (2) chronic poisoning of operatives, or of consumers of treated foodstuffs.

The first requirement in the safe use of a toxic material is an adequate knowledge of the mammalian toxicity of the compound. It must be admitted that, in the past, applied entomologists and economic botanists have not always paid sufficient attention to mammalian toxicity of sub-lethal quantities and the danger of ensuing chronic poisoning by the spray chemicals which they recommended. In the last three years the leading spray chemical manufacturers in the United States and this country have intensified the study of the toxicology of their products and the development of protective measures and antidotes to the poisons. In a number of organisations, the sale of a chemical is not allowed until adequate information on its toxicity is available. It is hoped that this practice will be generally accepted and in the future manufacturers will not bring a new insecticide or a new weedkiller on to the market until a comprehensive enquiry into the toxicology of the new chemical, as set out by Lehman, has been completed.

Practical protection

Provided the knowledge of toxic dosages, mode of entry into the body and pathological effects is adequate, it is possible to recommend measures to prevent *acute poisoning* of spray operatives, but it is important that the measures recommended are such that workmen can comfortably comply with them. We deprecate the recommendation of unpleasant or irksome practices, such as the wearing of gas-masks and gasproof clothing on hot summer days, and the subsequent placing of responsibility for casualties upon the carelessness of the workmen who discarded the protective clothing when temperature made the wearing of it unbearable.

With many of the toxic spray chemicals, weekly medical supervision and examination is necessary. In the case of certain important compounds, methods are now available for pre-diagnosis of early pathological symptoms, by diagnosing the uptake of the toxicant before any discomfort is felt by the patient.

Eight-point safety code

In addition, workpeople engaged in spraying must be made safety conscious, and this is only possible with a fairly high standard of intelligence and skill on the part of the spray operative. The old contention that any farmhand can be employed on spraying operations is dangerous and incorrect, if the operatives' safety is to be considered. To begin with, a spray operator must be a well-trained and skilled workman. His protection is then effected by the provision of our eight-point safety code comprising the following:

(1) A complete prevention of contamination by placing the operative in a gas-proof, air-conditioned cab fitted on the tractor, which precludes any possibility of skin contact with spray drift and inhalation of toxic fumes, and also ensures pleasant working conditions.

(2) The minimising of the necessity for handling spray chemicals. A number of accidents can be traced to splashing when tins are opened, or to the too-casual disposal of contaminated empty containers. To avoid this danger, we have, in our organisation, reduced the use of tins to a minimum by the introduction of bulk handling methods, a practice which lends itself to a much greater cleanliness of operations. Where the pouring of chemicals cannot be avoided, anti-splash tins are used.

In the bulk handling system installations, the spray liquid is pumped from the manufacturing plant in the factory to big storage

WRONG ↓

Courting disaster: (1) no protection to neck and face; (2) no protection of eyes; (3) cigarette handled with contaminated hands; (4) no overalls; (5) no gloves, bare arms and hands splashed with spray; (6) drum gives splash when pouring and is itself contaminated; (7) spray liquid splashed about on tank; (8) leather sandals absorb the spray and allow contact with skin

RIGHT ↑

Safe: (1) hood protects head and neck; (2) visor protects eyes and face; (3) no smoking; (4) white overalls protect clothing and skin; (5) rubber gloves; (6) special non-splash can; (7) no spray liquid splashed on tanks; (8) rubber boots, no spray absorption

tanks, whence it is taken to the distributive centres in large bridging tankers. At the distributive centres, the chemicals are transferred to depot storage tanks, from which small bulk handling automotive units draw supplies and deliver to the spraying machines.

(3) The use of protective clothing. Workpeople are issued with garments of a colour on which splashes become immediately conspicuous; where necessary they are fitted with hoods. These garments are laundered regularly every three days, by a method which prevents contamination with other washings. A neat clean garment encourages a conscientious workman to handle chemicals carefully and to work cautiously so as to avoid splashing and, moreover, enables him to wash off any accidental splashes which may occur, and which become immediately visible.

Natural rubber gloves and rubber boots, fitted with internal steel caps to protect the toes, are also provided.

For many operations visors are worn to prevent splashing of the eyes and face; these visors are more comfortable than goggles and can be easily flapped back when their use is not required.

(4) The issue of prophylactic drugs and supplementation of the diet to increase resistance.

(5) The enforcement, as a condition of employment, of a regular medical examination, so that dangerous quantities of toxic substance in the blood can be diagnosed long before pathological symptoms occur.

(6) The provision of first-aid kits which, in addition to the usual first-aid equipment and drugs, contain antidotes for use in emergencies, also instructions for treatment of casualties for the information of the doctor if it should happen that a casualty is treated by a doctor outside the company's medical organisation.

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toxicants which exceeds the tolerance allowed by the Food and Drug Administration, the produce must either be decontaminated, or it is seized and destroyed; in any case, the grower is traced and the whole of the remainder of the contaminated crop seized. The grower is taken to court and fined. Generally convicted offenders are placed on one year's probation, contingent upon their further disseminating knowledge of the working of the Food and Drug Act.

It will be seen from this that the enforcement of this protection of the consuming public is based on the establishment of tolerances of toxic residues. The recent large number of new insecticides and weedkillers has made it necessary to establish a number of new tolerances for this purpose, and a hearing of Government and industrial pharmacologists and entomologists before a committee of attorneys attached to the Federal Drug Administration has been in progress in the United States since the early part of this year. A large number of new tolerances are expected to be issued in the near future.

In the meantime, below are given a number of the tolerances which are in force today in California:

	Grains per lb.
Fluorine	0.049
Arsenic expressed as arsenic tri oxide	0.025
Lead	0.050
DDT	0.049

The British consuming public are not protected by any such legislation in so far as agricultural operations are concerned, although the activities of the food-preserving industry are regulated by an excellent Food and Drug Act. There seems to be a need in Great Britain for legislation similar to the Food and Drug Administration Act in the U.S.A., to forestall or eliminate fears of the public. The absence of such legislation could lead to carelessness and cause grave repercussions on the use of new methods of modern agriculture, which have done so much to increase the food production of the country.

Life of spray residue

In order to prevent toxic residues on and in plants, it is vital to know the half-life of spray residues. In the past, inadequate attention was given to this point. It is obviously necessary to state how long the spray residues are likely to remain active and consequently what interval should be allowed between spraying and harvesting. It is very important to give this information, because the spraying timetable must be fixed accordingly and the farmer must keep such facts in mind when considering any change in his plans. This is likely to arise if, for instance, a farmer decides to cut a crop which he originally intended for seed, thus reducing the interval between its harvesting and the spraying dates. If the farmer has been duly warned, he will obviously not embark on such a course if it would reduce the interval between spraying and harvesting below the safe minimum. It is therefore evident that any expansion of sprayed crop acreage must be accompanied by the assumption of responsibility for the health of the spraying workmen and consumer by all concerned.

The spray ejected from the nozzles forms a dense fog, but the man is protected by the gas-proof, air-conditioned cab in which he rides

Spray manufacturers

The manufacturers of spray chemicals must study the acute and chronic toxicities of new spray chemicals on which the establishment of tolerances for toxic residues can be based. This will allow the spray operations to be so timed that any toxic residue left at the time of harvesting does not exceed the tolerance. They must specify the nature and percentage of active ingredients and call attention to the toxic nature of the chemicals on the labels, stipulating the safety precautions and antidotes necessary and stating the safe interval which must be allowed to elapse between spraying and harvesting.

Machinery manufacturers

The manufacturers of spraying machinery must provide adequate safeguards to prevent spray drift and poisonous fumes reaching the operator, and must so design the spraying equipment that little or no maintenance is required during the spraying season before the machines can be decontaminated. The most important provision is that of a gasproof air-conditioned cab in which the operator can work safely and comfortably.

The grower

The grower must ensure that his workmen are adequately trained in the use of toxic chemicals; that they are medically examined before being placed on such work; that individuals who are medically unfit for the occupation are excluded; and that all operators engaged on the spraying of hazardous chemicals such as parathion and dinitro phenols are examined weekly and provided with the protection mentioned in our eight-point safety code. If he is not prepared to shoulder this responsibility, he should restrict his own spraying operations to the use of comparatively non-toxic spray chemicals, and leave the use of the toxic compounds to qualified spraying contractors. When using toxic compounds he should adhere strictly to the spraying time-table laid down by the manufacturer, and under no circumstances should he reduce the interval between the last spraying and the harvesting date below the time limit recommended. If he wishes to make any alteration in his harvest plans then he should consult the technical representatives of the suppliers of the chemicals or the local agricultural administration before so doing.

The spraying contractor should comply with the eight-point safety code set out above and ensure that his spraying equipment is of the correct construction to give

the operator protection. Many spraying machines were designed in the days when less toxic chemicals were in use and less attention was paid to the safety of the workmen, and are now utterly inadequate and unsafe for applying modern demands.

Contractors should employ supervisory staff who have the necessary professional qualifications. The fact that a man has been spraying for 20 years and survived the use of lead arsenate, copper and nicotine sprays, does not imply that he is qualified to deal with modern insecticides and weedkillers, which demand far more technical knowledge. In the most progressive countries it has become a legal requirement for a contractor to obtain a licence before he operates. Such a licence is not granted unless the contractor is either professionally qualified or has passed a rigorous examination by a board set up by the agricultural administration.

These proposals, at first glance, may appear elaborate, but it is considered essential if the great expansion of food production, which modern methods of weed and pest control can achieve, is to be realised without an alarming increase in the number of acute and chronic poisoning casualties. Until recently, the major part of the spraying operations in this country were carried out by a firm of scientific spraying contractors who had imposed upon themselves the restrictions mentioned, but now, with the increased use of these compounds by less qualified operators, fatalities are bound to occur if these restrictions are not generally observed. There seems to be no alternative, from the point of view of the protection of workmen as stressed by their trade unions, and for the protection of the consuming public, than to embody these restrictions in suitable legislation.

The introduction and enforcement of legislation which keeps abreast with the development of agricultural science such as is already in force in some states of the U.S.A. seems a low price to pay for the great increase in food production per acre.

BIBLIOGRAPHY

'Evidence before the U.S. Federal Security Agency Toxic Residue Hearing on Tolerance for Poisonous or Deleterious Substances in or on Fresh Fruits and Fresh Vegetables,' July 1950.

A. J. Lehman, E. P. Lang and others: 'Procedures for the Appraisal of the Toxicity of Chemicals in Food,' *Food, Drug, Cosmetic Law Qtrly.*, September 1949.

P. L. Bidstrup: 'Dangers of Insecticides.' address to Brit. Med. Assen., 118th Ann. Meeting, July 1950.

Donald Hunter, M.D., F.R.C.P.: 'Devices for the Protection of the Worker against Injury and Disease,' *Brit. Med. Journal*, March 4, 1950, **1**, 506-511.

NEW BOOKS

Plant Breeding

By A. L. Hagedoorn. Pp. 237. Illustrated. Crosby Lockwood, London, 1950, 12s. 6d.

Dr. Hagedoorn is well known for his distinguished work in the field of animal breeding and genetics. In a companion volume to his very successful book *Animal Breeding*, first published just over ten years ago, he now directs his genetical enthusiasm to the subject of the improvement of agricultural and horticultural crops. Although he has been primarily concerned with animal breeding and genetics, it was as a plant-breeding consultant to the French firm of Vilmorin Andrieux that Dr. Hagedoorn began his career, as he tells us in his preface. Since then he has never given up his interest in plant improvement and his experience as consultant geneticist in co-operating with both plant and animal breeders has been considerable; he has also been directly engaged in the production of sugar beet seed.

Plant Breeding is written chiefly for seedsmen and enterprising amateur gardeners rather than for those interested in more advanced breeding at research institutes. Possibly because this has been his main aim, much concerning recent advances in plant breeding and their scientific foundations has been barely mentioned or omitted. Yet plant breeding and the science of genetics are becoming more and more inseparable; even considering the scope of the book, a somewhat misleading impression is given of the status of plant breeding today. Dr. Hagedoorn fully admits the necessity of precise scientific knowledge: ' It is true that a great many valuable plant varieties have been made by breeders without scientific insight. But the waste of time and valuable material must have been appalling.' Yet often his ' firm convictions ' seem to rest upon the chance co-operation of nature. Certainly he takes a rather poor view of the use of statistical analysis in crop improvement, even in research institutes. ' Plant breeding . . . is subject to fashions, and I have a notion that the preoccupation with higher mathematics is due to a certain extent to one of those fashions.' Statistics may well be outside the interest and grasp of the amateur gardener intent upon roses or dahlias, but to belittle the value of the appropriate use of statistical analysis in modern plant breeding as a whole is surely incorrect.

Dr. Hagedoorn divides his book into three parts, the first of which deals with some general aspects of plant breeding—such as its role in large-scale and small-scale agriculture—and the more theoretical aspects of inheritance. Possibly a reader tackling the Mendelian laws of inheritance for the first time might flounder at some points, but the short chapters provide an adequate, if somewhat repetitive, account of the nature of genes, mutation, inbreeding and outcrossing, purity, disease resistance and other relevant subjects, although flights into the nature of viruses and one or two other controversial matters should have perhaps been avoided in an initiatory book of this kind.

In Part II, Dr. Hagedoorn turns from theory to practice, explaining methods of selecting and breeding vegetatively propagated, self-fertilising and cross-fertilising plants. The section covers an interesting range of subjects, including plant collections, the labelling, numbering and gadgets entailed in the work of selection and hybridisation, and shows. Part III provides practical hints on breeding and selecting some special groups of plants, temperate and tropical. Most of the chapters in this part, like those of the rest of the book, on account of their subject matter are likely to interest the agriculturalist rather than the horticulturalist.

Dr. Hagedoorn writes informally, almost conversationally. It is as though the reader is being personally conducted over experimental fields where the plants are actually growing; his book has the appeal of immediacy. What he has to say is stimulating, although one may not always be in agreement; readable and moderately priced, *Plant Breeding* should have a success similar to that of its companion, *Animal Breeding*.

THERESA ASHTON

Plantation Crops

Commonwealth Economic Committee Publication. Pp. xi and 103. H.M.S.O., London. 1950. 5s.

We welcome the second post-war issue of ' Plantation Crops, 1950,' one of a series which, before the war, was issued annually by the Commonwealth Economic Committee with the aim of presenting up-to-date summaries of production, international trade and consumption for various groups of allied commodities. The form of presentation of the summary shows a great improvement on its pre-war predecessors.

Most of the commodities reviewed play an important part in the Commonwealth's

trade with the rest of the world. Rubber, cocoa and tea are high on the list of dollar earners, but the two former were seriously affected by the conditions prevailing in the United States market during 1949.

Since the war there has been an expansion in the Commonwealth production of all the main plantation crops except cocoa, where disease in the Gold Coast has been a limiting factor, but even here output in 1949 was at a comparatively high level. Commonwealth exports have increased also though there was some decline in coffee exports in 1949.

The recovery in production and trade has been most marked for rubber, where there has been considerable progress in both Malaya and Indonesia. A general increase in the output of cane sugar in both Commonwealth and foreign countries has been supplemented by a recovery in beet sugar production in European importing countries with the result that world supplies in 1949 were about 10% larger than before the war; while the greatest developments have occurred in Cuba and American countries, there has been also a substantial increase in production in Australia, South Africa, the British West Indies, Mauritius and other Commonwealth countries. India, Pakistan and Ceylon still provide about two-thirds of the world exports of tea and the output of these countries, especially of India, has remained at a high level. Although coffee production in Brazil and other important producing areas in recent years has been lighter than before the war, exports have been heavier; the Commonwealth production, confined mainly to East Africa, is small but continues to expand. Notwithstanding export difficulties, tobacco output in the United States remains higher than pre-war, and among Commonwealth countries both Southern Rhodesia and Nyasaland have increased their production.

Estimates of consumption show some notable changes and contrasts. Thus although in the United Kingdom the consumption of coffee has more than doubled since pre-war years, it is still less than 2 lb. per head compared with 19 lb. in the United States. With the exception of South Africa and, to a less extent, Canada, Commonwealth countries favour tea, and *per caput* consumption in the United Kingdom is about 8 lb. as against little more than ½ lb. in the United States. Tobacco consumption in the United Kingdom has fallen since the war; nevertheless in 1949, at over 200 million lb., it was appreciably greater than before the war. Tobacco consumption in the United States has risen steadily, and there has been an even greater increase in Canada.

Rothamsted Report

Rothamsted Experimental Station Report for 1949. Pp. 178. Gibbs and Bamforth Ltd., St. Albans. 1950. 5s. (Foreign postage extra.)

The practical agriculturist treats scientific results emanating from Rothamsted with a respect not always accorded to other research stations of lesser renown. The historical background of Rothamsted partly accounts for this partiality, but it is also due to appreciation of the very practical results achieved at the Station. The extension of experiments to various outside centres in Great Britain, begun in 1921, and the more recent development of the work of the Station to the Empire and other countries is evidence of the ' awareness ' at Rothamsted of the part this institution is destined to play in the advancement of agricultural science.

The main section of the Rothamsted Report for 1949 is devoted to concise statements of the activities of the 15 departments into which the Station is divided, while another section presents abstracts of nearly 200 contributions to agricultural literature during 1949. Thus, within the compass of a small volume, the reader is introduced to the problems engaging attention, is informed of the progress made during the year and is provided with a convenient record of recently completed work.

One is struck by the emphasis attached to the study of technique in the conduct of these scientific experiments. X-ray methods are used in the study of soils; the use of radio-active fertilisers assists in the study of fertilisers in relation to soil and plant; the use of aerial tow-nets and suction traps operated from balloons is employed in studying the drift of insects in the upper air. Apparatus is especially designed to facilitate the study of the germination of seeds; improvements are made in the method of measuring the volume of solids, water and air as they exist in the field; improvements in the electron microscope make it possible to determine the sizes and shapes of virus particles in the sap of infected plants; while mechanical means for computation make possible more complicated types of statistical analysis.

The results of over five years' investigations on nutritional problems in forest nurseries are summarised in one of two special reports. In nurseries of Sitka spruce and other conifers, striking benefits resulted from the application of fertilisers on very acid soils, and from partial sterilisation by steam and formalin. In the second of these special reports, the results of 24 years' work on the relation between soil cultivation and crop yields are summarised. Among the main conclusions drawn are that seedling weeds can have a very serious effect on the early development of a crop, from which it never fully recovers, tilth being of less importance than weediness and moisture content.

The reports of the departments contain much information in abbreviated form. One reads of the study on problems of soil fertility and of attempts to control the rate of action of nitrogen and phosphate fertilisers to suit different needs, for at present about 80% of the phosphate applied as soluble fertiliser is not recovered in crops in the first few years. Another investigation shows that there is an upper limit to the amount of water that can be transpired by green vegetation; it is therefore possible to estimate from simple weather data the amount of irrigation required for a crop. In connection with nodule bacteria and leguminous plants, ineffective nodule bacteria have been found to be induced not only by the strain of bacteria, but also by hereditary factors in the plant. Factors affecting the rate of uptake of nitrogen, phosphorus and potassium by roots, and on the uptake of mineral nutrients from solutions sprayed on the leaves are being studied. It has been found that appreciable amounts of mineral nutrients can be taken up from solutions sprayed on the leaves. The transmission of viruses by aphides is being studied by using plants containing radio-active phosphorus. It is found that insects are more numerous after wet weather in summer and warm weather in winter; from this a method of forecasting insect abundance has been developed. The mode of action on insects of toxic substances, and factors affecting the susceptibility of insects to toxic materials are under investigation and may lead to a rational choice of new toxic substances and to the more efficient use of existing insecticides and fungicides. Investigations continue on the solubility of DDT and rotenone in the wax layer of the insect cuticle, and on the susceptibility of insects at different stages in their lives, on the development of resistant strains of insects and on the effect of systemic insecticides as contact and stomach poisons.

Rothamsted offers research facilities for post-graduate students, but the number that can be accommodated is at present strictly limited by lack of laboratory space. In view of the value of post-graduate work to the Empire and to science, one can but hope that a way may be found to extend such facilities in the near future.

D. H. GRIST

Tractor Safety Factors

Accidents with tractors in the field are not infrequent, and on this account the following discussion of the mechanical factors influencing tractor stability in working is of interest. It has been condensed from two bulletins by Mr. R. H. Cochrane, B.A., Lecturer in Agricultural Engineering at Lincoln Agricultural College, New Zealand, which were published by the Canterbury Chamber of Commerce.

THE two main factors which influence tractor stability are (i) drawbar pull and (ii) engine torque. This article deals with both aspects and discusses the factors which cause wheeled tractors to overturn. Possibly a better understanding of the forces involved and the conditions which invoke them may help to reduce the number of accidents which occur in the course of their employment.

Drawbar pull

The modern tractor engine delivers power in a number of ways, but farm tractors perform most of their work in the form of drawbar pull and it is in the changing of engine horsepower into drawbar pull that the greatest loss of power occurs. Tractor performance in the field begins with the contact the final drive mechanism makes with the ground. As the wheel turns it is the resistance to shear of the soil imprisoned between the tread bars plus friction between the tyre and the soil that prevents the wheel from slipping. The backwards force exerted by the tread bars against the sides of the rack imprinted in the soil plus friction between the tyre and the soil cause an equal and opposite force to act at the axle. This force is the drawbar pull.

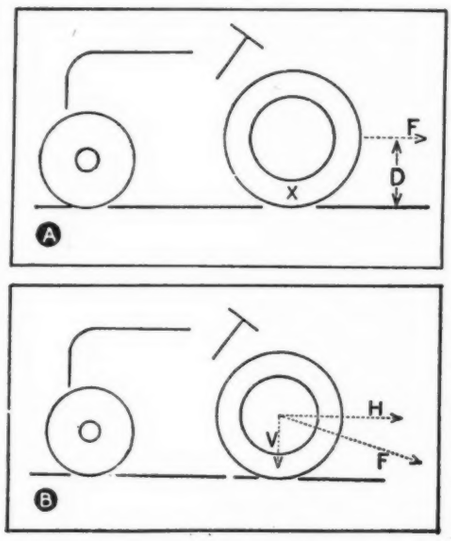
The grip of wheels varies with their size, shape and number of lugs or bars, and the weight upon them. Still more does the grip vary with the structure, moisture content and the type of soil. A better grip is obtained by adding weight to the rear wheels.

Overturning backwards

When the tractor exerts a drawbar pull, the weight is transferred from the front wheels, which have a tendency to be lifted owing to the drawbar pull having a turning effect about the point of contact of the wheels with the ground.

Diagram A illustrates this. This moment, or turning effect, causes weight transfer from the front wheels and in extreme cases rearing of the front of the tractor. Diagram B, again representing the resistance to drawbar pull by F, indicates how its vertical component V acts downwards thus adding weight to the rear wheels.

Various devices are available to help tractors get a better grip on the soil. They are steel wheels with lugs, half tracks, rotaped equipment, all manner of attachments to pneumatics (strakes), and finally full tracks. The latter get the better grip on the soil and do less damage to its structure.



Resistance to drawbar pull
(*a*) weight transference from front to rear, (*b*) vertical resistance acting downwards as well

The state of the soil is all important, for the moisture content and the soil structure make a considerable difference to the amount of drawbar pull available.

The height of the hitch is one of the most important points. Any horizontal force such as F above the point of contact between the wheels and the ground results in a weight transfer from the front wheels to the rear wheels (see diagram). If F is large enough the tractor will rear. The higher the horizontal force is applied the greater will be the tendency to cause rearing due to an increase in the distance D and its effect on the moment of the force about X.

There is less risk of rearing if the hitch point is behind and below the rear axle. Under extreme conditions a hitch underneath and forward of the rear axle is recommended. The use of mounted implements reduces the risk of turning over backwards.

Overturning sideways

Turning over sideways is more easily done and as it happens more quickly it is more dangerous. As indicated in diagram C, when a tractor is on an incline its weight acts vertically downwards through the centre of gravity and if the line of action of the force passes over the tipping axis overturning occurs. The higher the centre of gravity the more easily does this happen. Obviously a large factor of safety must be allowed to take into consideration stones and unevenness of slope.

The weight of a tractor is not the only force which will cause a tractor to tip over sideways; if it moves in a curve centrifugal force appears—acting outwards. Diagram D illustrates a row-crop tractor turning, with centrifugal force acting outwards tending to turn the tractor over sideways. The axis over which tipping occurs joins the points of contact of the front and rear wheels with the ground.

Centrifugal force varies directly with the square of the speed and inversely with the radius of the turn. This means that the speed of the turn plays an important part in increasing the centrifugal force. One of the most dangerous practices is to drive along a sideline at speed, when the tractor has no load, and then to turn up the slope. Increasing the width between the rear wheels is a means of decreasing the danger, and a tractor with a low centre of gravity is less dangerous than one with a high centre of gravity.

Torque reaction

A third danger arises from torque reaction—a force which acts inside the tractor. Torque is a measure of the effect produced by a twisting force and engine torque is a measure of the capacity of the pistons to twist the crankshaft. Inertia tends to keep still bodies at rest and those that are moving in uniform motion. When a car is at rest, it takes a greater effort to start it moving than is necessary to keep it moving once it has started.

Torque reaction is most easily understood by considering the driving pinion and the crown wheel, inside the differential housing. When starting a tractor, or when accelerating, there is a tendency for the

driving pinion to climb upwards because the ring gear resists being turned. This tends to cause the rear axle housing to twist in the opposite direction to the drive wheels and if the reaction is sufficient it may result in the rearing of the front end of the tractor. Wheel weights, or rubber tyres filled with liquid add to the inertia by their extra weight. This is not an argument against adding weight to the rear wheels, which is very necessary in some circumstances, but additional care must be taken when either wheel weights or water-ballasted tyres are used. It is only with high engine torque and a sudden engagement of the clutch that the reaction can become dangerous.

To overturn a tractor as a result of torque reaction the centre of gravity of the front end must be raised to a point vertically over the axle. It should be realised that the turning moment here is about the back axle as contrasted with that from drawbar pull which is about the point of contact of the back wheel with the ground.

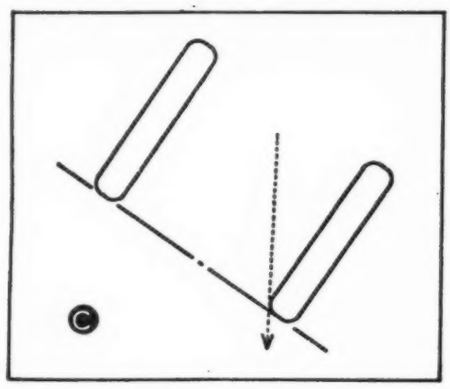
Should the front end of a tractor rear, as the result of torque, the higher it rises the more dangerous does the position become. This is due to the fact that as its centre of gravity approaches the rear axle or pivot, as the front end is lifted, the turning effect of the weight of the front end is reduced, while the turning effect of the lifting force remains the same. As a result the tractor tends to rear relatively slowly at first and then speeds up as the front end rises higher and its inertia is overcome.

Another set of conditions can be even more dangerous. When the driving pinion turns, either the ring gear must turn with one or both of the rear wheels or the driving pinion will have to ride up the ring gear. What happens generally is that one or both of the rear wheels will start to slip —most likely one—but if both stick and the engine continues rising overturning may happen. A good deal of energy is needed to cause overturning in this way; if the clutch is engaged at low engine torque, when both wheels cannot turn, the engine will probably stall, but if at high engine torque with wide open throttle and in low gear overturning may happen.

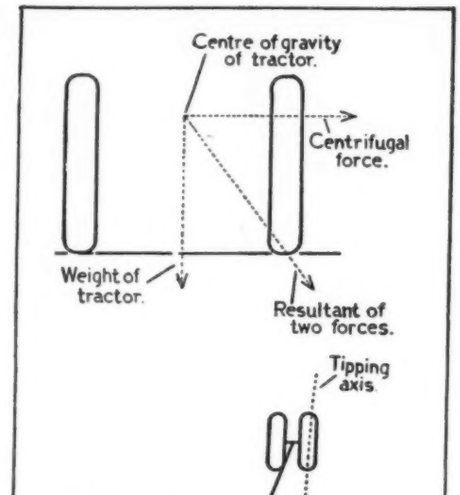
When facing up a slope the conditions are more dangerous, depending, of course, on the angle of the slope. In general crawler tractors are safer on hillsides than wheeled tractors, due to their low centre of gravity, the extra weight of the larger engine, the track mechanism and the low setting of the drawbar.

When going up a steep slope with no load at the drawbar, a sudden opening of the throttle of a powerful engine might cause the tractor to overturn backwards, due to the intertia of the tractor mass which has to be overcome before the whole will move at a higher speed.

A load at the drawbar helps to keep the forward end down against torque reaction if the drawbar is behind and below the rear axle. Hitching above the rear axle or level with it increases the turning effect of the forces about the rear axle tending to turn the tractor over backwards.



Turning over sideways



Centrifugal force

Additional points

If the tracks are wide, a large surface area is provided to carry the weight of the machine. This with its relatively light weight per unit area may cause the crawler to slip sideways down a slope. A narrower track tends to dig in because a smaller surface area is carrying the same weight. If a crawler tractor, while sliding down a slope catches an obstruction on the edge of the lower track, the momentum may well be enough to turn it over.

Another, sometimes unsuspected, danger arises when the driver of a crawler tractor moving down a slope tries to turn on the slope. This danger applies only to tractors where steering is achieved by means of a clutch and brake.

When going down a slope, however, with an idling engine acting as a brake, disengaging a track clutch to make a turn has the opposite effect. The result is the tractor swings in a direction opposite to that intended by the driver. If the intended turn was being made to avoid an obstruction the result of this unexpected turn in the wrong direction could easily be disastrous. Obviously, to make the desired turn under the circumstances outlined the brakes would have to be used as well, or else the opposite clutch would be disengaged.

Some maxims for safety

(*a*) Hitch at the drawbar, or forward of and underneath the axle.

(*b*) Take care with engaging of the clutch. Pay particular attention to this if the rear wheels are in a ditch or depression especially if the tractor is loaded.

(*c*) Make sharp turns slowly, particularly on slopes.

(*d*) Avoid turning sharply up a slope when the tractor is not loaded.

(*e*) When working on slopes adjust the rear wheels to the maximum width where possible.

(*f*) Always go downhill in gear.

(*g*) Make sure when buying a tractor that the brakes are adequate and keep them in good repair and adjustment.

(*h*) Remember that there are slopes upon which standard wheeled tractors cannot be expected to work with safety.

(*i*) Guard against the possible effects of torque reaction by never engaging the clutch suddenly at wide throttle settings.

(*j*) If the rear wheels are stuck for any reason never try to move forwards by opening the throttle and engaging the clutch suddenly. Under such circumstances try to back out or fetch another tractor.

Members of the Section on Agronomic Botany. Dr. F. T. Wahlen (marked with a cross) was President of the Section and official delegate of F.A.O.

Some Highlights of the Seventh International Botanical Congress

ERNA GROSSBARD, B.Sc.

SOME 1,500 botanists from fifty different nations met in July last in Stockholm for the Seventh International Botanical Congress. The programme of the congress revealed a wide diversity of topics, ranging over such varied subjects as paleobotany, plant physiology, phyto-geography, agronomic botany, cytology and plant pathology. The Congress was opened by His Royal Highness the Crown Prince of Sweden on July 12, and held under the Presidency of Professor C. Scottsberg. There were 15 different sections, and in all over 600 papers were presented. It is obviously impossible in the space available to give a survey of the whole range of contributions, but, in the agricultural context, some of the outstanding features are reported below.

General lectures to plenary sessions

Five general lectures were given to plenary sessions of the Congress ; they included a lecture by Dr. F. T. Wahlen, official delegate of the Food and Agriculture Organisation of the United Nations, who stressed the need for collaboration between plant breeders, plant pathologists, plant physiologists, ecologists and agronomists to make the most effective use of the available area of land on the earth.

Mention should also be made of the discourse by Professor F. W. Went on the inter-relation of climatic factors and plant growth. Other papers dealing with similar topics were delivered by Professor G. E. Blackman (England) and Dr. O. V. Heath (England).

The water relationships of crops, including the effect of drought and the nature of drought-resistance, were dealt with by Prof. O. Stocker (Germany), Prof. H. Walter (Germany) and Prof. Oppenheimer (Israel), special attention being paid to the mechanism by which plants balance water losses with moisture absorption and adapt themselves to extremely dry climatic conditions.

Plant breeding

Breeding new and improved varieties of crop plants occupied an important place in the discussions, both in relation to annual crops and also fruit and forest trees. The production of varieties resistant to severe climatic conditions was prominent, and papers appeared dealing with the breeding of varieties of barley resistant to very low temperatures and strains of apples able to withstand severe winter frosts, using as parent material for hybrids, varieties from the Baltic regions of Russia and Sweden. The improvement of forest trees by hybridisation was also discussed with regard to timber and cellulose production.

Breeding for disease resistance

Breeding for disease resistance came in for much consideration, and notably the many complex factors which help to constitute a resistant strain. In this regard much interest and some controversy centred round the subject of hypersensitivity as a factor in disease resistance ; this can be defined as the reaction of a plant to the attacks of fungi, which can only exist in living cells ; the so-called obligate parasites. Hypersensitive plants are, in fact, particularly susceptible to fungus attack ; but because the invaded cells die off so rapidly, the available food supply of the fungus is destroyed and it becomes hedged in by a zone of dead cells, and on this account cannot advance into healthy tissues. Moreover, the dying cells frequently produce a toxin which accelerates the death of the fungus, and if the reaction is complete before the fungus has had a chance of forming spores, the attack may be arrested.

Prof. A. J. P. Oort (Holland) described an example of hypersensitivity in wheat attacked by loose smut. Prof. K. O. Mueller (England) put forward a theory on the mechanism of this reaction, and Dr. N. T. Flentje (England) explained the variation in the pathogenecity of different races of the damping-off fungus Rhizoctonia towards various host plants in terms of ' hypersensitivity or something very like it.' Hypersensitivity is, however, by no means a general phenomenon, although varieties of plants displaying this have been bred.

Variations within parasitic fungi

One of the difficulties encountered by plant breeders is variation in the strains of parasites attacking plants ; while man is attempting to breed resistant varieties of crops, nature is playing a similar part in regard to the parasites ; thus by mutation and hybridisation new races of parasites can emerge which will attack varieties formerly exhibiting resistance. In this connection Prof. E. C. Stakman (U.S.A.), in two papers, surveyed in detail the variations which have been recorded in races of rusts and smuts attacking cereals in the U.S.A. and Mexico. He discussed the frequency of occurrence of certain races of these organisms and outlined the manner in which plant breeders and pathologists could take advantage of this knowledge.

Strains of viruses

The existence of strains of pathogens of varying virulence is not confined to fungi or bacteria, and a special section of the Congress dealt with virus diseases. It was presided over by Dr. F. C. Bawden (England) who, in his discussion, considered the different strains of the viruses causing tobacco necrosis. He pointed out that frequently plants are found which, although their roots contain the virus, do not manifest any symptoms of disease. Apparently non-virulent strains of viruses exist, and it has been established that plants containing non-virulent strains can be protected by them against the effects of infection by virulent strains. For this reason investigations into strain specificity are of great importance.

Viruses are nucleoproteins, and from plants invaded with a number of the tobacco necrosis viruses, nucleoproteins have been isolated which appear to be homogeneous. One strain that has been isolated differs from the others in its chemical and physical properties and, when it is subjected to certain forms of treatment, loses its power of infection, although other strains, when similarly treated, are not affected in this way.

Another aspect of virus disease is whether a virus can multiply within the insect vector. Dr. L. M. Black (U.S.A.) pointed out that he had demonstrated conclusively that not only can a virus multiply within the insect but it can also be transmitted to its progeny. Working with the clover club virus, transmitted by leaf hoppers, Dr. Black has shown that the virus can persist up to the twenty-first generation of leaf hopper progeny.

Virus disease can be transmitted by grafting and budding, and as citrus fruits are usually propagated in this way, the danger of transmitting viruses by this method of propagation may be very great. In this connection Prof. L. J. Klotz (U.S.A.) discussed psorosis, which was formerly a major disease of citrus trees ; it has, however, now lost much of its importance because the characteristic symptoms appearing on the foliage enable nurserymen to select virus-free propagating material with comparative ease.

In many citrus growing areas the sour orange, which is the most commonly used root stock, is susceptible to a number of virus diseases. Prof. Klotz suggested that certain maladies are probably caused by related viruses, and work is in progress to endeavour to find a combination of scion and root stock resistant to disease which can replace the sour orange as stock.

Antibiotics

Dr. P. W. Brian (England) introduced a new approach to the understanding of the problem of pathogenecity. He reported that he had found, in the laboratory, that a parasite of the tomato—the fungus *Alternaria*—produced an antibiotic ; when this material was injected into healthy tomato plants it produced exactly the same symptoms of disease as does the fungus itself. Dr. Brian concluded that a correlation might exist between the formation of an antibiotic in plant tissues and the characteristic symptoms of the disease itself ; accordingly, while some antibiotics might control plant disease, others might themselves cause pathogenic conditions.

Prof. S. A. Waksman (U.S.A) surveyed the significance of antibiotics in the physiology of micro-organisms. He discussed the strain specificity shown by antibiotic producing micro-organisms, with special reference to those producing streptomycin ; he discussed the purpose which the antibiotic served from the point of view of the fungus or bacterium which produces them, and concluded that antibiotics cannot be regarded either as foods or as a means of protection.

A number of papers appeared also on the relations of antibiotics in the soil. Prof. D. Gottlieb (U.S.A.) demonstrated by X-ray techniques the mode of adsorption of certain antibiotics on colloids, and showed that the chemical constitution of an antibiotic determines whether it would be adsorbed and inactivated in contact with soil. Mr. E. G. Jefferys (England) discussed the stability of antibiotics produced by soil inhabiting moulds. He had proved that antibiotics produced from moulds in the laboratory were most stable in the soils from which the moulds had themselves originated. The pH of the soil was an important factor in determining the persistence of antibiotic activity in any particular soil.

Professor Frits W. Went, head of the plant Physiology Department, California Institute of Technology, Pasadena

Antagonistic and symbiotic relationships

Prof. H. Osvald (Sweden) recorded that plants such as couch grass, rye grass, fescue and others gave rise to root exudates which could interfere appreciably with the development of rape or of wild oats in contact with them. He concluded that such exudates might play an important part in competition between plants in cultivated fields as well as in natural vegetation.

Mycorrhizal relationships

Mycorrhizal associations were dealt with by Dr. E. Melin (Sweden), with reference to pine trees: He has measured the transfer of phosphorous by mycorrhizal hyphae to young pine seedlings. Prof. E. Björkman (Sweden) described the benefit which the fungus derived from the plants with which it was associated. Mycorrhizal development was most characteristic and prolific when a surplus of soluble carbohydrate was available in the roots of the infected plants.

Spread of plant disease by airborne spores

Dr. P. H. Gregory (England) reported the results of work on the spread of diseases by airborne spores. It is well known that the risk of infection in this way decreases with distance from the original point of infection, by reason of diffusion of the spore cloud. He had studied the relation-

Professor Hugo Osvald of the Royal Agricultural College, Uppsala, Sweden. He was Vice-President of the Congress

ship between the concentration of spores in the air and the intensity of spore deposition. He considered that this mode of attack should be of value in relation to the practical application of dusts and sprays in the field.

Plant nutrition

Many aspects of plant nutrition were considered. A novel feature was the use of fertilisers in forestry, and various aspects of this were discussed by authorities from the U.S.A., Norway and England. Prof. S. O. Heiberg (U.S.A.) reported the beneficial effects of applications of potassium fertilisers to forest trees suffering from deficiency of that element ; while Dr. H. Roback (Norway) and Dr. L. Leyton (England) discussed the relation of phosphorous and nitrogen to afforestation of sites infected with the plant *Calluna*. Other subjects discussed were the effect of trace elements, the use of tissue cultures in studying various problems of disease resistance, pathogenecity and other processes in plants, and the use of radioactive isotopes in physiological investigations. Papers on the latter subject were presented by Prof. M. Calvin (U.S.A.) and Dr. R. Scott Russell (England), with special reference to the utilisation of radioactive phosphorous and carbon.

It has only been possible in this brief survey to mention a few of the more outstanding points of interest to agricultural readers. The Congress presented a unique opportunity for establishing personal contacts between workers in the same field. It covered an enormous number of different aspects, and when the proceedings come to be published, it will be found that the records comprise a full survey of many new aspects and advances in botanical knowledge.

CORRESPONDENCE

The New Locust Threat

TO THE EDITOR,

DEAR SIR,

The Editorial comment in the October issue of *World Crops* on the Desert Locust threat to Africa and south-western Asia is most welcome as it draws attention to a serious menace. It suffers, however, from some inaccuracies which require correction.

It is correct that investigations during the past twenty years warranted the hope that the locust menace ' was in a fair way to being adequately controlled,' but at no time has it been suggested by responsible persons that ' most of the requisite scientific knowledge is available ' to enable the locust problem to be solved provided adequate financial resources are available. The fact is that the way to solve the problem appears reasonably clear, but it is certainly not a short one, and not only money, but a great deal more investigation is needed for a solution. It is true that two other African Locusts, the Red and the Migratory, are under reasonable control, but it has never been claimed that the same stage has been reached with regard to the Desert Locust (*Schistocerca gregaria*). Its distribution area extends over the whole of Africa north of the equator and through the Middle East and Arabia to Pakistan and India. This region comprises some of the most difficult country in the world, and certain areas are still inaccessible, partly for physical but mainly for political reasons. It is no wonder that our knowledge of the outbreak areas of this locust is still very inadequate. This was fully realised by all concerned.

It was, nevertheless, considered essential to institute the Desert Locust Survey, with the primary aim of supervising outbreak areas, which were known and accessible, and of extending investigations to suspected areas. It was hoped that the Survey would be able to discover and to control incipient outbreaks, but it has never been suggested that it would immediately be able ' to institute effective control measures . . . at any point where danger threatened.' The resources of the Survey were certainly inadequate for such a purpose; but this was not due to official unwillingness to provide greater facilities, since the plans for the Desert Locust Survey, prepared by an Advisory Committee of scientists, were approved in full. The plans had to be realistic, and the first limiting factor was scientific personnel.

The number of scientists who took part in wartime anti-locust work was very small and only a couple were diverted elsewhere; it was obviously impossible to recruit at once the full number necessary for the Survey organisation, which also had to build up its bases, transport, etc. The Survey plans, therefore, have been based on gradual expansion: three field teams were envisaged in the first two years, expanding later to six. The Survey was constituted in October 1948 and field work commenced in January 1949 with three teams; but only one field entomologist could be recruited in time; other teams were led by experienced technical officers taken over from the previous locust control organisation.

The winter of 1948-49 was abnormal as regards rainfall in Eastern Arabia, which was at that time (and still is) inaccessible for political reasons. Further developments occurred mainly in areas outside Desert Locust Survey responsibility, and led to a multiplication of swarms, culminating in the present plague.

It was obviously impossible to expect an organisation, only a few months old, to deal with such catastrophic developments, nor is it correct to say that ' these events have been foreseen for some time.' They could not be foreseen, since scientists do not claim ability to forecast such abnormal events as occurred in Arabia. It may be argued that the Survey should have been started on a much larger scale, but money alone cannot produce an efficient organisation to deal with a problem which requires not only first-class field investigators but also sufficient time to arrive at reliable conclusions. In this respect, there is perfect accord between scientists and the official bodies involved, and the former have no reason to complain. It is a significant fact that, in spite of the present emergency which requires concentration on immediate practical anti-locust measures, research plans have not been curtailed. On the contrary, the officially accepted view is that research should be intensified, and scientists should not be diverted to organise locust killing, as they were during the war. The large anti-locust campaign which is now necessary will be conducted by a new temporary organisation, Desert Locust Control, with experts of the Survey and of the Anti-Locust Research Centre advising on all matters of strategy, tactics and technique.

While sufficient attention has been paid

to the organisation of both locust control and research on the British side, the international aspect of the problem has also not been forgotten. The work of the Desert Locust Survey goes hand in hand with similar organisations established by the Governments of Egypt, Pakistan, India and Persia, and all information is regularly exchanged. Plans for anti-locust campaigns are also correlated between different countries. The collaboration is not yet perfect, but its existence is already a great step forward. The coming Desert Locust plague may provide a salutary lesson to the few countries which prefer to keep aloof, hoping that efforts of others may save them trouble and expense.

It is fair to say that the recent history of anti-locust measures provides an outstanding example of perhaps slow, but well-founded, progress, to which both scientists and official and public bodies contributed their share. The present Desert Locust plague could not possibly have been averted; no promises to do so were made by anyone and it is hardly right to describe as a ' failure ' what is essentially a natural disaster. The issue of the campaign now developing cannot be forecast, as so much depends on unpredictable weather conditions, but there is reasonable hope of success, although it may take at least two-three years to achieve it. The costs will be considerable, but it has to be remembered that the food production of the many countries involved is at stake.

In this emergency, it is essential to co-ordinate the efforts of all concerned—governments (British and foreign), scientists, and public bodies; the responsible press can also do much towards this end.

Yours faithfully,

B. P. UVAROV,

Director, Anti-Locust Research Centre.

British Museum of Natural History,

Cromwell Road,

London, S.W.7.

Tractor Fuel Economy

ECONOMY in the use of fuel on the farm helps self-sufficiency in just the same way as saving feedingstuffs. Losses can occur during the storage of the fuel on the farm, and there can be wastage through spilling the fuel while pouring it into the tank of the tractor. There can also be leakage from the tractor tank, pipes and carburettor. But most waste comes through imperfect combustion of the fuel in the cylinders of the engine, and from losses of energy in the transmission of the engine power from the rear wheels of the tractor to the implement being operated. There can in addition be serious losses due to inefficient loading of the tractor.

The most convenient way of storing tractor fuel is in an underground bulk storage tank with a hose delivery pipe. The tank and pump should be sited so that the tractor can be brought to the pump without being driven along the yard or a metalled road—this is important when the tractor has to be used with spade-lugged wheels—but the opening to the storage tank must be against a roadway hard enough to bear the tank lorry which brings the bulk supply.

Storage in drums and cans is likely to continue on many farms. Where this method is used, any cans or drums that have become battered until the fuel can seep through their rims should be discarded or repaired, and a large funnel should be used for filling the tractor tank from the cans. If ordinary two-gallon petrol cans are employed, it is important that the can, when being emptied, should be held with its opening uppermost, so that the air replacing the fuel can flow steadily into the can.

It is sometimes possible to save fuel by changing the standard setting of the carburettor ; usually, however, it is best to accept the manufacturer's setting or, if the jet is an adjustable one, to control the carburettor in accordance with the manufacturer's instruction, for it must be remembered that a very weak mixture, though it may give a low fuel consumption, can bring with it such troubles as burnt exhaust valves which can be expensive to put right.

The greatest savings of fuel are by skilful management of the actual operations of the tractor. In this ' science of tractor management ' we can include adjustment of the load to suit the tractor's capabilities, and the avoidance of idle running. We can include also the elimination of losses of fuel due to difficult starting and inefficient running caused by some electrical or mechanical defect in the engine, and losses due to poor wheel grip.

The first point to remember in considering loading is that much of the energy given by the engine is used to transport the tractor and implement, and that a basic amount of fuel has to be used whether the implement is doing a heavy job or a light one. Therefore, the size and adjustment of the implement should be such as to make full use of the capabilities of the tractor. If the tractor seems underloaded, then a wider bout of work should be attempted or, if the kind of operation allows it, the tractor should be run in a higher gear.

Wheel slip

At the other end of the scale we have to avoid giving the tractor a heavier load than it can comfortably manage. Overloading uses the engine at too near its maximum output and will cause it to wear out quickly. It is likely that overloading will also bring wheel slip, with consequent waste of fuel. Wheel slip is a direct loss of power and therefore a direct loss of fuel.

One way of reducing the slip is, of course, to reduce the load of work ; but it often happens that wheel slip occurs long before the work load is great enough to put a full demand on the engine. In such cases, if the grip of the driving wheels can be improved, the tractor will be able to deal with a heavier load more economically. When tyres are slipping so much that they are on the point of digging in, their rolling resistance often becomes so high that the engine is stalled.

Spade-lugged steel wheels rarely slip seriously without digging themselves in, and calculation is rarely necessary. Moreover, an inspection of the impressions left in the soil by the lugs of the wheels when the tractor is pulling its load will give sufficient guide to whether any excessive slip is taking place. The grip of steel wheels can sometimes be improved by ballast to cause deeper penetration of the lugs into the soil. A frequent cause of slip is, however, worn spade lugs ; as well as losing their total length for penetration, the worn lugs become rounded instead of wedge shaped.

When the driving wheels are gripping well, the driver must avoid taking undue advantage of their grip by increasing the load to such an extent that the engine is overworked. When the speed of the engine seems to have been brought down and the exhaust note indicates that the engine is labouring, the driver should reduce the load or change to a lower gear.

Keeping the tractor engine in good order is a sound step towards making the best use of tractor fuel. Leaking valves or gummed piston rings can cause the engine to consume much more fuel than is warranted by the output of power, and faults in the ignition system can make the engine difficult to start. Difficult starting, which in the case of a vaporising oil engine often involves emptying and refilling the carburettor chamber several times, wastes fuel directly, and it can waste it indirectly by causing the driver to keep the engine running while he is loading a trailer or adjusting his implements.

(From *Agriculture*, the journal of the Ministry of Agriculture.)

Blister Blight Control Developments

THE results of recent trials carried out on tea estates in Ceylon by Dr. H. Dike of Universal Crop Protection, Ltd., working at the Tea Research Institute, St. Coombs, have, it is claimed, shown that dust-blowing machines must inevitably cupersede knapsack sprayers, chiefly besause of the high cost of coolie labour and also because it has been established that the time of applying the fungicide is equal in importance to the amount applied.

Experiments with varying concentrations of fungicide showed that some bushes, even although they had received a very high concentration, still became infected with the disease, and it was established that the interval between applications is one of the factors deciding whether the tea will succumb or not. Young growth is the most susceptible and therefore the younger the age of the shoots after pruning the more frequently is dusting or spraying required —say every five or six days during the first year after pruning and every eight days during the second and third years, assuming the bushes are pruned every three years. The complete answer to this problem of spraying and dusting intervals is yet to be found and work on this project is still going on at the Tea Research Institute.

The Whirlwind at work in Ceylon. Note how the dust is directed to the tops of the tea bushes

Under ideal conditions dust can float at least 200 ft. over the bushes

Sprays and dusts

During the monsoon period infection by Blister Blight can, and quite often does, reach the alarming height of 88%. This can be reduced to 10 to 20% by using a single-nozzle knapsack sprayer, and to 20% to 40% with a double-nozzle sprayer of the same type which, while allowing a greater acreage to be covered per day, does not seem to give such a thorough coverage. By using a dusting machine infection can also be reduced to between 20% and 40%; but what is important is that 30 to 40 acres can be covered *per hour* by machine as opposed to little more than one acre *per day* by a coolie with a knapsack sprayer; also no transport of water is required by the former method. This output of the duster, at least 200 times that of hand-operated machines, has very important implications in that estates can wait for optimum weather conditions under which to carry out the work, as an average-sized tea estate can be dusted in a few days quite easily. On the other hand, hand-operated work has to go on more or less continuously in order to get round all the bushes; for example, in order to spray a 400 acre estate once a week with hand-operated sprayers 100 men are required.

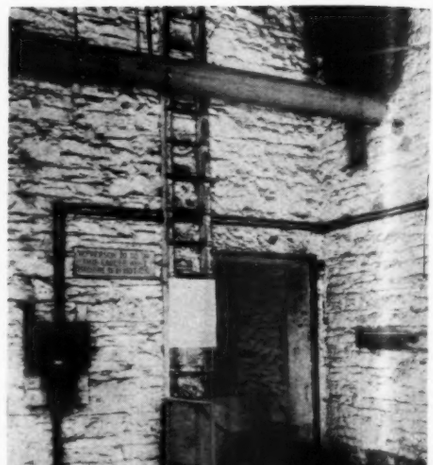
Unlike spraying, the perfect conditions for dusting are those of light rain or mist, because there are then no up-currents of air and therefore good conditions for drifting; damp conditions also help the copper compound particles of the fungicide to become dissociated from the filler and effect a better dispersal over the leaf surface.

Dust blower

A machine capable of dusting or spraying tea has now been developed requiring a team of four men to operate it. It can be carried on the back of a lorry or any other vehicle or, if necessary, by hand. When used for dusting, this machine, the Whirlwind, blows out a very light fungicidal dust, specially adapted to the machine, in a blast of air and under still conditions it can penetrate a distance of 200 ft. at least. A ' rolling ' cloud effect is obtained and the dust ' rolls ' over and over along the tops of the bushes, the bottom of the cloud ' rolling ' into the plant and keeping up the whirling motion as it circulates round the leaves; the air blast disintegrates and the dust becomes lighter and lighter as it settles over the plant. Appearance of a ' smoking ' bush after the cloud has disappeared indicates good coverage of the leaf area. The Whirlwind uses 7 to 10 lb. dust per acre and the equipment carries over 1 cwt. of the material.

It is hoped to reduce infection considerably by preventive dusting, which may obviate the necessity for the various cultural methods employed at present, such as trying to save bushes by not plucking too hard, cutting down shade trees or pruning earlier to let the bushes grow in the dry season—all methods which go against the true nature of tea growth and adversely affect its quality.

FARM MACHINERY



(*Left*) **Storage space 18 ft. by 72 ft. for about 176 tons of grain. Ducting (9 in. diameter) of portable grain blower shown above rafters.** (*Centre*) **Examining 'Dryvent' channels laid on the floor of the storage space.** (*Right*) **Portable fan, heater and control gear; above, section of grain blower trunking**

'Dryvent' Installation for Grain Storage

The accompanying photographs show an actual installation for drying and storing grain on a 600-acre Lancashire farm in the north of England. Grain is harvested by a Massey-Harris combine, after which it is put in an intake pit and elevated to a drier. At the bagging-off end of the drier the grain is conveyed by a portable blower, capable of handling 3½ tons per hour, through various bends to a point 15 ft. above ground level, at which height it enters the storage rooms. On the floor of the storage rooms is set up 'Dryvent' equipment consisting of main and side trunkings through which air is passed and allowed to circulate through the grain.

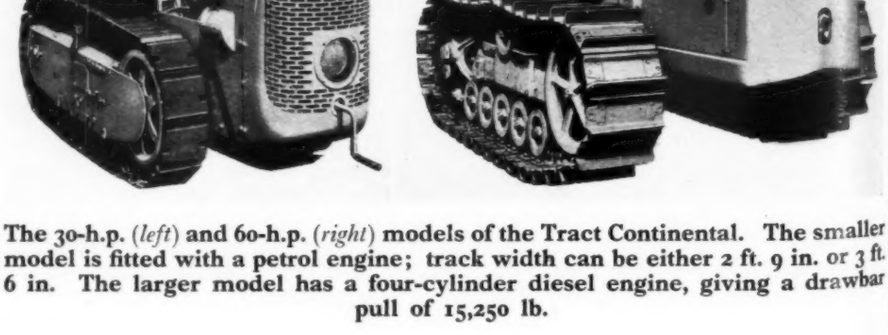
A portable chassis placed outside the place of storage carries a fan, heater and control panel for the 'Dryvent' so that outside air may circulate through the grain. Grain can be stored to a depth of 6 ft. from the tops of the trunkings and distant-reading thermometers are placed at various positions in the grain itself to register its temperature.

A 'Dryvent' calculator, provided with the installation, enables correct ventilation to be obtained as, after ascertaining the outside air temperature and the temperature of the grain itself, it indicates the amount of heat to be used to reduce the relative humidity of the air to the required percentage. In this way drying is effected at a rate of about ½% moisture being removed daily from the bulk grain.

This type of installation has recently been introduced by Mitchell, Colman and Co. Ltd., of London. The installation, although primarily designed for grain storage, is also suitable for other crops such as roots and vegetables.

Spain's Machinery Expansion

Manufacture of agricultural machinery in Spain has developed considerably since 1943, when production began in the Seville factory of the Sociedad Anonima de Construcciones Agricoles, set up through the collaboration of private capital with the State-financed Instituo Nacional de Industria. It is aimed to produce and assemble every type of agricultural implement and machine, including tractors, and in general the production of all types of materials or installations applicable to agriculture. Although there is certainly a demand for machinery it is limited by the fact that over the greater part of Spain the configuration of the soil does not permit large scale mechanised exploitation. However, that the demand is still there is shown by the production figures for agricultural machinery which have risen from 1,793,236 pesetas in 1945 to 4,529,745 pesetas in 1947 and 8,246,140 pesetas in 1948.



The 30-h.p. (*left*) **and 60-h.p.** (*right*) **models of the Tract Continental. The smaller model is fitted with a petrol engine; track width can be either 2 ft. 9 in. or 3 ft. 6 in. The larger model has a four-cylinder diesel engine, giving a drawbar pull of 15,250 lb.**

WORLD CROP REPORTS

Decline in world production of rice

The world rice harvest for 1949-50 (August-July) is estimated at 334,000 million lb. of rough rice, 3% less than the post-war record of 343,000 million lb. in the year before. Most of the decline occurred in Asia, with a moderate decrease in Africa. Record crops were harvested in Europe, North and South America.

Asia's rough rice harvest, representing 92% of the world total, is estimated at 308,000 million lb. or about 10 million lb. less than in the preceding year. **China's** crop was the smallest in several years. Rebel activities in **Burma** and **Indo-China** caused a decrease in the acreage and output, and slight declines occurred in **Pakistan** and **Korea.** Production was larger in the **Philippines, Thailand, Malaya, Taiwan,** and **Japan.**

July floods in **China** resulted in a pronounced decline in the harvest, estimated at 98,000 million lb. of rough rice from 45,630,000 acres. This compares with 106,000 million lb. in the preceding year on approximately the same acreage. Before the war production and acreage averaged (1931-37) 110,000 million lb. and 48,850,000 acres, respectively.

The official estimate of production in **India's** reported areas is 73,693 million lb., a slight gain over 73,061 million in the year before.

The rough rice production of Asia's surplus area—**Thailand, Burma,** and **Indochina**—is estimated at 33,000 million lb., a reduction of 1,800 million from the preceding year, and 7,000 million less than the pre-war average. **Burma's** acreage fell 21% below 1948-49, and production was 16% less. The crop is estimated at only 57% of the pre-war average.

In **Indochina,** conditions similar to those in Burma indicate acreage and production have been declining since 1947-48. The 1949-50 crop estimate is 84% of the pre-war average.

Thailand is the only country in this area where production has continued to increase since the war, and indications are that the harvest was above the pre-war average. The official estimate of production is 11,850 million lb. of rough rice.

The rice acreage of **Pakistan** increased about 200,000 acres, but unfavourable weather and plant diseases caused a moderate decline in the harvest compared with last year. Good weather in **Japan** resulted in the largest crop in 20 years. Drought conditions in **South Korea** during the planting season reduced the acreage 6%, but the yield per acre was only slightly less than in the year before.

Production in the **Philippines** showed a gain of 4% from the preceding year's record. Rice acreage has increased steadily since the war, from 4.1 million acres in 1945-46 to 5.5 million acres in 1949-50. Favourable weather in the **Malayan Union** resulted in a record crop from a record acreage.

Europe's 1949 crop was only slightly larger than in 1948, but well above the pre-war average. Its rough rice production is estimated at 2,500 million lb., compared with 2,480 million a year earlier, and 2,400 million before the war. A decline in the rice acreage of **Italy** was compensated by increases in several countries having small acreages. Rice is now raised in increasing quantities in several countries of Europe where little was grown before the war. France, Greece, Hungary, and Rumania are cases in point.

Africa's production decreased, but continued substantially above the pre-war average. A decline in **Egypt,** the largest producer, was the principal factor in the reduction. Acreage declined 11%, but the yields per acre were as high as those harvested in the bumper crop of the year before. **Madagascar's** acreage reportedly is above the preceding year, and climatic conditions so far have been reported favourable. Plans for increasing production are taking shape in several countries of Africa, and the total production of that continent in coming years may show an expansion.

The record rice production of the Western Hemisphere in 1949-50 is estimated at 13,400 million lb., slightly larger than in the year before, and about double the 6,800 million before the war. Above-average yields were harvested in both **Brazil** and the **United States,** whose combined production accounts for three-quarters of the Hemisphere total.

North America harvested its sixth successive record rice crop. Production of 5,200 million lb. compared with 5,000 in the year before and 2,800 million before the war.

Mexico and **Panama** also again produced record crops. Mexico added nearly 60,000 acres to the preceding year's record. Although the yield per acre was below average, production exceeded 1948-49. **Cuba's** harvest approximated the 1949 record.

South America's record rice harvest is estimated at 8% larger than a year earlier, and more than double the pre-war average. Excellent growing weather in **Brazil** from January to April resulted in the largest crop that country has ever produced. **Colombia** and **Paraguay** also had record harvests, and **Chile's** production exceeded the preceding year.

Although production was down in **Argentina** compared with the year before, it was 79% above the pre-war average (1935-36/39-40) and about equal to the war-time average (1940-41/44-45) production. The crops of **Surinam** and **Uruguay** also were smaller than in the preceding year, but were well above both the pre-war and war-time averages.

Ecuador's 1950 production is forecast at about 35% less than in 1949, as the result of reduced acreages and adverse weather in some localities. **Peru** will harvest a crop even smaller than in 1949. For the second year water supplies are deficient in the main rice-producing areas, and the harvest is expected to be 20% below last year's short crop.

(From *Foreign Crops and Markets.*)

Rape and mustard in Pakistan

The final forecast of the area under rape and mustard for the year 1949-50 is 1,540,000 acres, as against 1,530,000 acres of the previous year, and shows an increase of 0.7%. The decrease in the Punjab and Bahawalpur State largely offset the increase in the acreage of this crop in other units of Pakistan.

The final forecast of the yield of this crop for the year 1949-50 is 254,000 tons, as against 265,000 tons of the previous year, and shows a decrease of 4.2%.

Australian wheat and rice

According to our Australian correspondent, the Division of Plant Industry of the Department of Agriculture of New South Wales estimates that this season's total acreage of wheat in that territory will be only 3,400,000 acres, as compared with last season's 4,206,000 acres. Some 400,000 acres have not been sown owing to prolonged rain.

Australia's rice crop this season may easily reach 67,000 tons and it may come close to the all-time record yield of 75,000 tons in 1944. Most crops already harvested have yielded more than 2 tons to the acre.

More N.S.W. bananas

New South Wales banana growers who have followed irrigation plans laid down by the local Department of Agriculture report a yield of 400 cases per acre as against the average of 90. (In Australia bananas are marketed in cases containing 1¾ bushels, or 75 lb.)

Developments in the World Raw Cotton Situation

Final figures of world production of commercial cotton this season are not yet available as the Southern Hemisphere crops are only now being harvested, but on the bases of the latest statistical estimates the 1949-50 world crop will be about 30,500,000 bales, or approximately 2,300,000 bales more than the 1948-49 output.

The United States is the principal contributor to the increase in world production this season, having harvested a crop of almost 16,000,000 bales, as against 14,650,000 bales last season. Mexico takes second place with a record yield of 985,000 bales—415,000 bales more than in 1948-49. Larger crops were also gathered in India, Pakistan, Russia, Argentina and Turkey. Chinese cotton production suffered as a result of the hostilities, but the quantity delivered to the mills for commercial use was larger than in the previous season as a result of the restoration of internal communications. The only important cotton-growing country which failed to grow as much cotton as in 1948-49 was Uganda, where unfavourable weather adversely affected yields.

Both Egypt and Brazil planted larger acreages to cotton than last season, but heavy leafworm damage in the former and excessive rains in the latter so reduced the average yield per acre that their respective harvests appear only about the same size as in 1948-49.

WORLD CARRYOVER AND PRODUCTION OF COMMERCIAL COTTON IN THE WORLD

American in Running Bales; Foreign in Equivalent 478 lb. Net Bales (000's omitted)

World Stocks, July 31, 1949

U.S.A.	5,300
Canada	55
Mexico	130
Other N. America	20
Brazil	850
Argentina	410
Peru	120
Other S. America	110
U.K.	1,580
France	310
Italy	355
Russia	750
Germany (all Zones)	150
Holland	65
Belgium	85
Sweden	70
Spain	75
Czechoslovakia	70
Poland	120
Other Continent	260
India	1,100
Pakistan	70
China	600
Japan	395
Turkey	90
Other Asia	110
Egypt	650
Belgian Congo	85
Other Africa	320
Australia, etc.	50
Afloat	300
	14,655

*World Production, 1949-50**

U.S.A.	16,000
Mexico	985
Other N. America	50
Brazil	1,550
Argentina	575
Peru	320
Other S. America	110
Europe	195
Russia	2,700
Turkey	445
Persia	95
India	2,300
Pakistan	950
China	1,000
Burma	20
Other Asia	200
Egypt	1,800
Belgian Congo	220
British East Africa	320
Nigeria	50
French Africa	155
Portuguese Africa	140
Sudan	260
Other Africa	30
Elsewhere	30
	30,500

*Preliminary.

Adding the 1949 carryover to the indicated 1949-50 world production gives a total available supply for the season of 45,155,000 bales, which compares with 41,052,000 bales last season. Of this season's total, United States cotton accounts for 21,300,000 bales, or about 47 per cent.

To prevent the accumulation of further surpluses in the United States, the U.S. Government has decided this year compulsorily to restrict the cotton acreage to around 22,000,000 acres—*i.e.*, a reduction of about 25 per cent. on the 1949 area. Under average growing conditions, such an acreage should produce a crop of around 12,000,000 bales, or some 4,000,000 bales less than in the past season.

World production of other growths in 1950-51, on the other hand, should be larger than the 14,500,000 bales (equiv. 478 lb.) estimated to have been grown this season. Increased acreages have been planted in Mexico, Turkey, Egypt and Russia and are planned in both Pakistan and India. The prevailing high prices may also be expected to encourage extended cotton growing in several minor producing countries. Acreages to be sown to cotton in the South American republics next autumn cannot be predicted at this early stage, but there would appear no reason to anticipate any reductions. Assuming average growing conditions, the indicated 1950-51 planted acreage outside the United States should produce an aggregate crop of 16,000,000 bales, or 1,500,000 more than the 1949-50 estimated figure.

Prospects for world production of commercial cotton next season can therefore be very tentatively estimated at around 28,000,000, as against 30,500,000 bales for the present season.

World consumption in 1950-51 is very difficult to estimate, as so much depends on developments in the broad political and economic picture, and on the extent to which cotton is replaced by synthetic fibres. However, on the present prospect a world crop of 28,000,000 bales, if realised, should fully suffice to meet the requirements of the world's mills during the coming season; it is very doubtful if world consumption will expand much above the 27,720,000 bales estimated for the present season, and may conceivably be less.

(From the *Journal of the Empire Cotton Growing Corporation*, **xxvii**, 3.)

S. African table grapes popular

South African table grapes, of which Barlinka and Waltham Cross are the leading varieties, have never been more popular overseas than they are now. During the 1949-50 season, which, except for the late crop in the Hex River Valley, has now ended, South Africa exported 36,000,000 lb. of grapes, the highest on record since the export trade started. In terms of foreign currency, this year's exports earned £1,800,000 for the Union. It is expected that when the final calculations are made, South Africa will have earned about £3,500,000 through the export of fresh deciduous fruit this season. Early heavy winter rains damaged the ripening of Barlinka and Almeria types in the Hex River Valley, so that big quantities which ordinarily would have made the export grade are now being diverted to the local market. About another million lb. are expected from this area. Of this year's exports more than 75% went to Britain, the rest to the Continent of Europe, the United States and Far Eastern countries. Up to the end of April this year, 528,000 20-lb. boxes of grapes were supplied to the South African market. This is still a little more than 100,000 boxes fewer than at the same time last year. The Deciduous Fruit Board expects, however, that last year's figure will be reached.

Israel increases

The Israel Ministry of Agriculture reports that about 400,000 dunums of summer crops have been sown this season, as against 225,000 last year (a dunum is approximately one-third of an acre). The principal crops are maize (155,000 d.), durrah (100,000 d.), sunflower seed (50,000 d.), and oil seeds (40,000 d.).